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OPERATION CROSSROADS

(1)

REPORT OF

BUREAU OF SHIPS INSTRUMENTATION GROUP

SECTION IX

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Director
Defense Atomic Support Agency
Washington, D. C. 20301

Displacements of
Shock Mounted Equipment

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DISPLACEMENTS OF SHOCK MOUNTED EQUIPMENT U, ⁽⁸⁾

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1 JAN 1965

Report On

DISPLACEMENTS OF SHOCK MOUNTED EQUIPMENT

This report was prepared by Dr. IRWIN VIGNESS of the Naval Research Laboratory. The work was carried out under his direction, assisted by Mr. J. P. WALSH and Lieutenant PERRY EGBERT, USNR, also of the Naval Research Laboratory.

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MAXIMUM RELATIVE DISPLACEMENTS SHOCK MOUNTED
APPARATUS WITH RESPECT TO THEIR SUPPORTS

("X" Gage Measurements)

INTRODUCTION

Objectives

1. A considerable amount of Navy gear mounted aboard ship is held in position by flexible supports. These equipments have several modes of vibrations whose frequencies are easily determinable. The maximum displacements of these equipments with respect to their supports are of interest from the viewpoint of the suitability of the mounts in protecting the equipments from damage and also from the viewpoint of determining the relative intensities of shock at different locations on a ship. The lower modes of vibrations of the mounted equipments are generally in the range between 4 and 20 cps. As the response (the "response" of a point on an equipment is considered to be the maximum displacement of that point with respect to its supports) of an equipment is dependent on the type of mounting and the position of measurement it is practical only to compare responses of similar equipment at given locations on the equipments, although sufficient data are included so that a more extensive analysis is possible.

2. The principal objectives to be gained from measurements of maximum displacements of shock mounted equipments with respect to their supports are therefore:

- A. Determination of the suitability of the mounting system with respect to
 1. Flexibility properties of the mounts,
 2. Clearances provided, and
 3. Locations of the mounts on the equipments.These factors are considered first in importance and can be obtained in sufficiently good approximation with little detailed analysis.
- B. Determination of the relative intensity of shock, as to its effect on shock mounted apparatus, as a function of location within a ship and of distance and orientation of the ship with respect to the source of the explosion.

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3. Shock mounted electronic equipment was found to be most suitable for these studies. The most satisfactory condition existed when a given type of gear, mounted in a standard manner, was found on many different ships. This occurred for several types of radio and radar gear. Lead gages were used with these gears and with other equipment where frequency determinations could easily be made or where, for some other reason, the displacements were of particular interest.

Ships Instrumented with Lead Gages

4. As the amount of effort that could be put forth to any particular phase of instrumentation was limited, only the following ships were instrumented with lead gages. These ships were chosen as capable of giving information concerning shock intensity as a function of distance from the bomb, and to a lesser extent, as a function of location within a ship. The few applications in the APA type ships were on equipment especially installed for the Crossroads test. The ships instrumented are listed in Table I.

Table I - Ships Instrumented with "X" or Lead Gages:

<u>Destroyers</u>	<u>Battleships</u>
DD367 Lamson*	BB34 New York
DD389 Mugford	
DD390 Ralph Talbot	<u>Cruisers</u>
DD403 Trippe	CA24 Pensacola
DD404 Rhind	CA25 Salt Lake City
DD406 Stack	
DD408 Wilson	<u>Submarines</u>
DD410 Hughes	SS184 Skipjack**
DD411 Anderson*	SS196 Sea Raven
DD419 Wainwright	SS308 Apogon**
<u>Attack Transports</u>	SS335 Dentuda
APA57 Gilliam*	
APA64 Bracken	
APA77 Crittenden	
APA79 Dawson	

*Sunk during Able test, no test data obtained.

**Sunk during Baker test.

The locations of these ships with respect to the explosion for the Able and Baker tests, are shown on Plates 1 and 2.

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Method of Measurement

5. The determination of the maximum displacement of one object with respect to another was made by "Lead Strip" gages, or "X" gages, which consist of a tapered lead angle soldered to a small rigid base, as shown of Figure 1. The lead is about 1/32 inch thick and its length is trimmed to

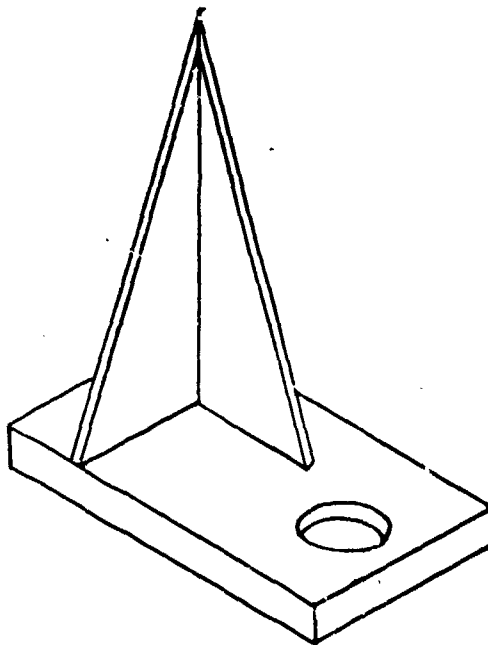


Figure 1 - "X" gage, or tapered lead angle maximum displacement gage.

suit any particular use. The gage is attached so that the relative motions of two parts will crush a portion of the lead angle and so allow the nearest approach of the two parts to be determined. The device is reasonably accurate for sudden velocity changes (for velocities up to about 50 ft/sec) encountered in normal shipboard shock work. The results may be inaccurate because of permanent distortion of a gage support, usually such conditions were easily noticed and the readings were discarded.

Experimental Data and Comments

6. The experimental data together with all information obtained concerning these measurements are tabulated for each target ship involved. The data is complete except for some submarines that were sunk by Baker test and which should provide information of great value if they become available for the determination of instrument recording.

The data usually includes the following:

- a. The name and model or type of shock mounted apparatus under study.
- b. The name of the ship and the location of this apparatus on the ship.
- c. A sketch of the apparatus showing gage locations.
- d. Type, location, and clearance of shock mounts used.
- e. Identification number of a photograph of the equipment. Some photographs of typical installations are shown on Plate 7.
- f. Deflection indicated by each gage. (It is to be noted that each gage identification number contains the number of the ship involved followed by a single number to identify each piece of shock mounted apparatus, and followed by a small letter to designate the gage on a given piece of apparatus.)
- g. Notes and comments as may be necessary.

7. The type of mount is often designed as L or C. These are illustrated on Figure 2 below. The C type mounts have fairly linear load deflection curves until they bottom solidly. The L type mounts are fairly linear, for deflections

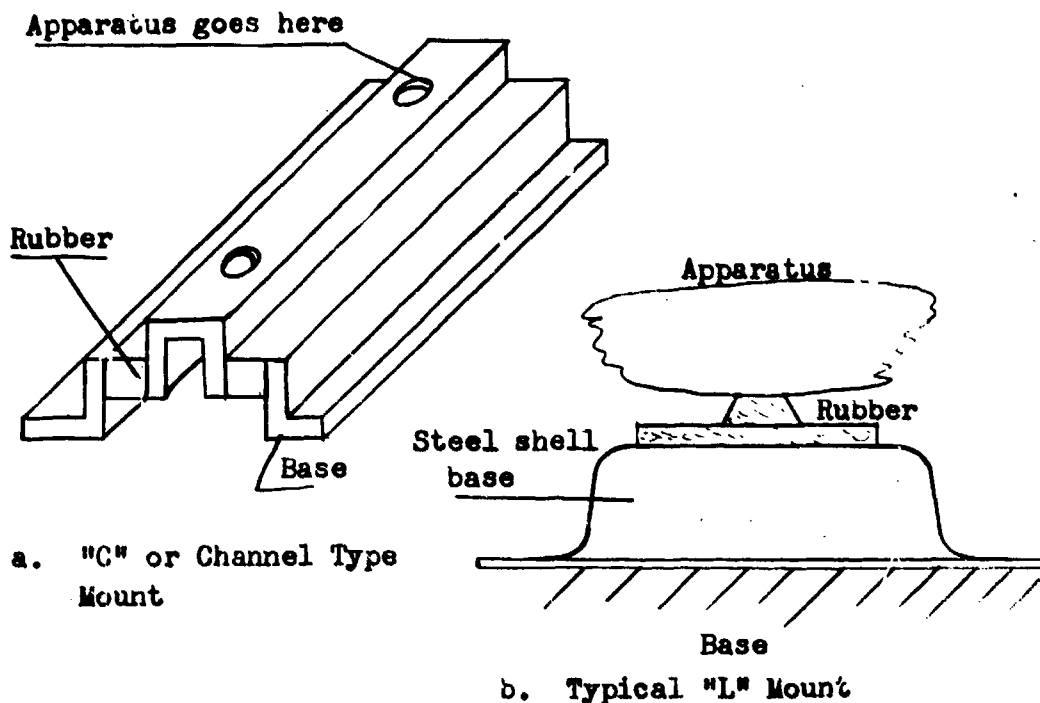


Figure 2 - Principal types of shock mounts.

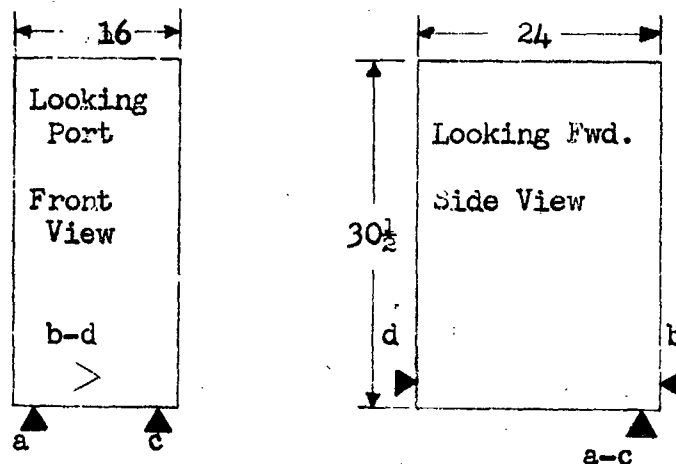
along their axis, until they bottom on their shoulders after which time large compressional restoring forces come into play.

8. There will generally be comments following the individual pieces of apparatus instrumented. There will also be comments at the conclusion of each ship considered which will summarize results for that ship. Finally there will be a general summary and conclusion following the presentation of data.

DD389 MUGFORD

DD389 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Transmitter Room, First Superstructure Deck. The transmitter is in the port side of the room.



Type of Mounting: Short C type mounts on each bottom corner.

Photograph: AA CR 140-2295-2, 3, 4.
AA CR 140-2294-11, 12.

Deflection (inches):

Gage DD389 #1	a	b	c	d
Baker	0.12	0.07	0.11	0.13

The mounting can be assumed to have linear response for these deflections.

Comments

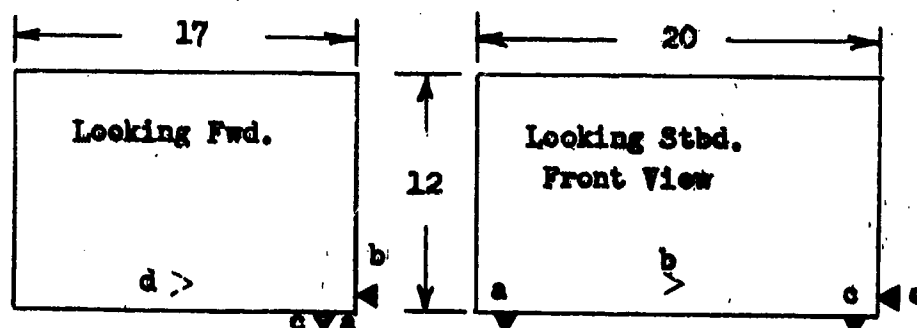
Able: This ship was not instrumented for Able Test.

Baker: The ship was beyond the range of appreciable damaging action of the bomb. There was negligible shock and no appreciable damage of any kind.

DD390 RALPH TALEOT

DD390 #1 Gages:

Location: On Radio Receiver Model RBO-2, in Radio Transmitter Room, First Superstructure Deck. The receiver is on the starboard side of the room, above a motor-generator set, and distant from all exterior bulkheads.



Type of Mounting: L type mounts on each of the four bottom corners. Clearance about 3/8 inch.

Photograph: NA CR 95-737-11

Vibration Modes:

Rocking Fore and Aft	8.05 cps
Rocking Athwartship	7.5
Translation Vertical	9.6

Deflection (inches):

Gage DD390 #1	a	b	c	d
Baker	0.15	0.11	0.15	0.03

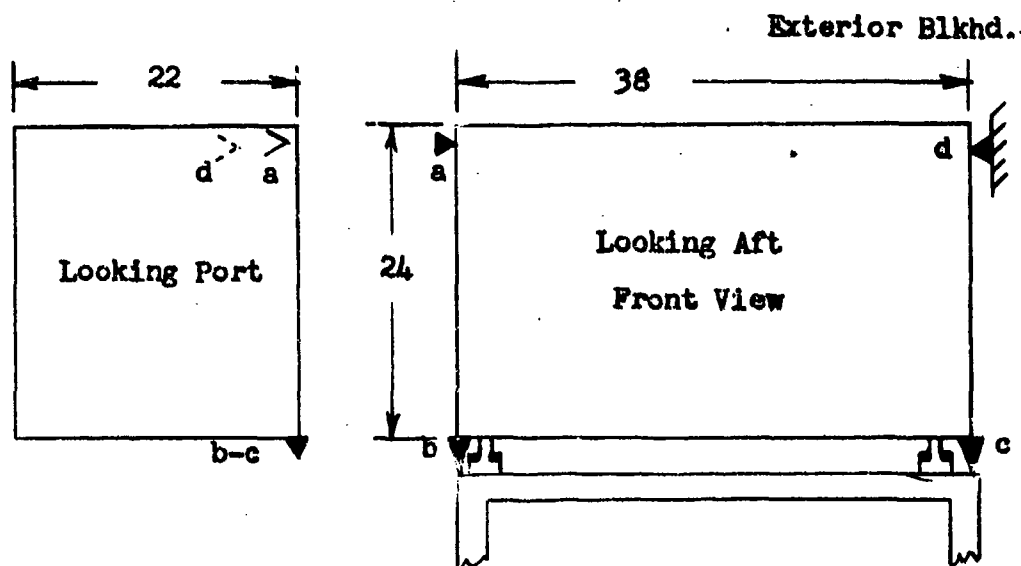
Comments

Able: This ship was not instrumented during Able test.

Baker: There were negligible shock displacements. The ship suffered no appreciable damage.

DD390 #2 Gages:

Location: On Range and Train Indicator Model SG type CRP. In C.I.C. Room which is located on the second superstructure deck.



Type of Mounting: C type mounts on each bottom end run the full depth of the equipment.

Photograph: BA CR 95-737-12

Vibration Modes:

Rocking Fore and Aft	7.6 cps
Rocking Athwartship	11.2

Deflection (inches):

Gage DD390 #2	a	b	c	d
Baker	0.33	0.25	0.11	0.57

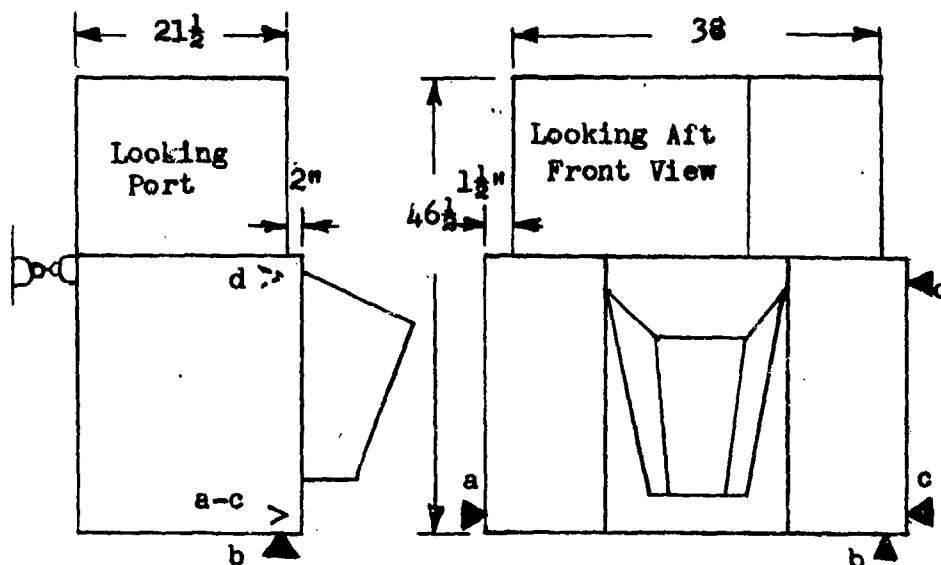
Comments

Able: This ship was not instrumented during Able test.

Baker: There was negligible shock and no appreciable damage to the ship or its equipment.

DD390 #3 Gages:

Location: On Plan Position Indicator in C.I.C. Room, Second Superstructure Deck (starboard aft side of room).



Type of Mounting: Short C type mounts on each of the four bottom corners. L type mounts on the upper back corners of the lower unit. Clearance slightly over 1/4 inch for the bottom mounts.

Vibration Modes:

Rocking Fore and Aft	5.7 cps
Rocking Athwartship	4.4

Deflection (inches):

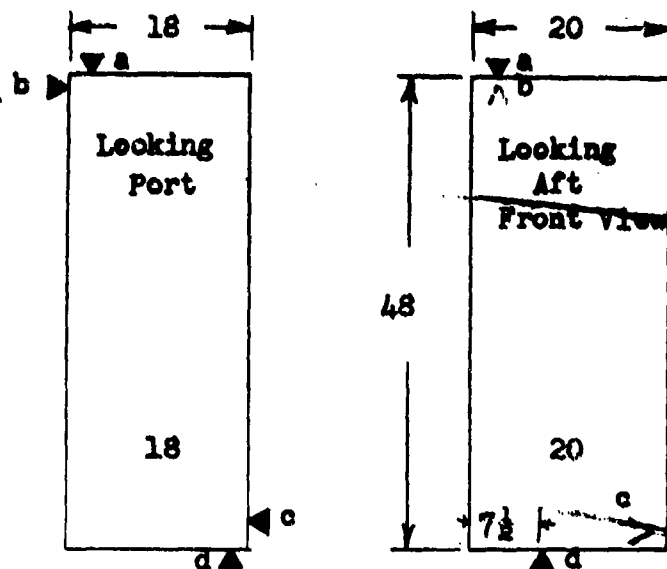
Gage DD390 #3	a	b	c	d
Baker	0.15	0.13	0.57	1.00

Comments

Able: This ship was not instrumented during Able test.
Baker: There was negligible shock and no appreciable damage.

DD390 #4 Gages:

Location: On Radar Transmitter Model SC3 type CG, in Radar Transmitter Room, Second Superstructure Deck. (Near aft bulkhead.)



Type of Mounting: C type mounts on the four bottom corners and on bottom edges between the corners (total eight mounts on bottom). Two C type mounts on the upper back corners. About one inch vertical clearance.

Photograph: BA CR 95-738-2 and BA CR 95-738-3

Vibration Modes:

Rocking Fore and Aft	7.1 cps
Rocking Athwartship	7.4
Translation Vertical	9.7

Deflection (inches):

Gage DD390 #4	a	b	c	d
Baker	0.09	1.33	0.07	0.07

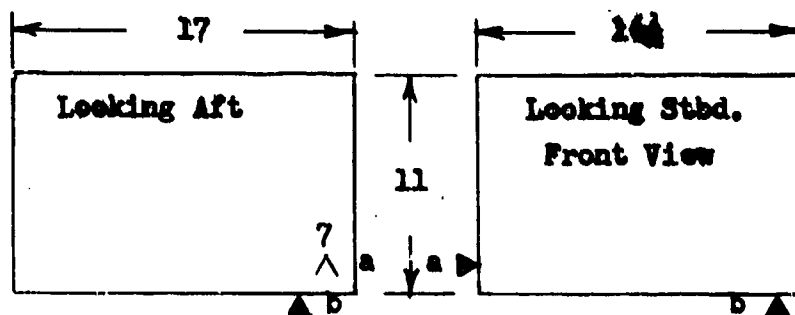
Comments

Able: This ship was not instrumental for Able test.

Baker: There was negligible shock and damage. In spite of the negligible shock intensity the displacement of the top of the tall narrow transmitter was 1.3 inches. This indicated the large displacements caused by rocking modes of poorly mounted equipment.

DD390 #5 Gages:

Location: On Model BN Transmitter and Receiver, type CFM-43ACB, in Radar Transmitter Room, Second Superstructure Deck. (Starboard aft corner of room.)



Type of Mounting: L type mounts on four bottom corners.
Clearance about 1/8 inch.

Photograph: BA CR 95-738-4

Vibration Modes:

Rocking Fore and Aft	10.1 cps
Rocking Athwartship	11.8
Translation Vertical	21.3

Deflection (inches):

Cage DD390 #5	a	b
Baker	0.13	0.08

DD390 General Discussion

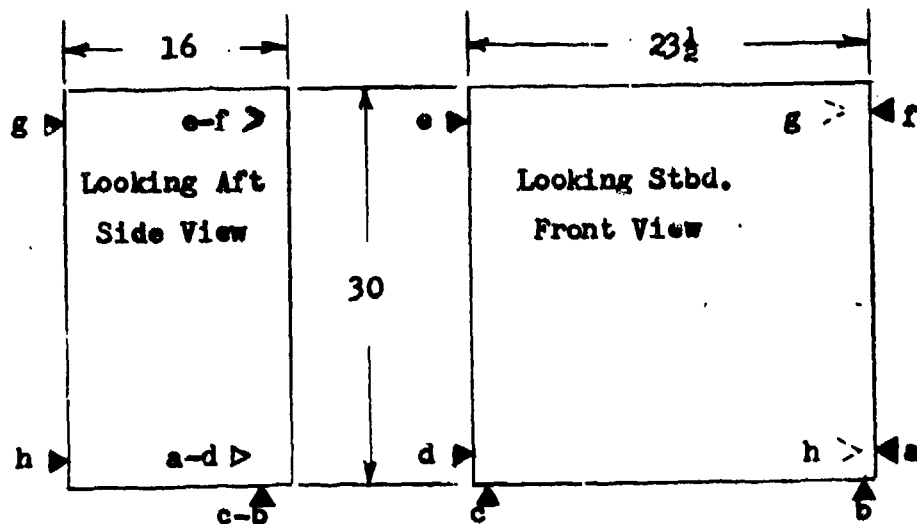
Able: This ship was not instrumented for Able test.
Baker: The ship was beyond the effective range of the bomb.
There was negligible shock and damage.

DD403 TRIPPE

Lead gage data was obtained for this ship only for the Baker test.

DD403 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Transmitter Room, First Superstructure Deck. The transmitter is in the starboard side of the room.



Type of Mounting: The unit is mounted in an angle iron frame to which it is attached by means of C type mounts on the four bottom corners.

Photograph: AA CR 140-2293-1

Deflection (inches):

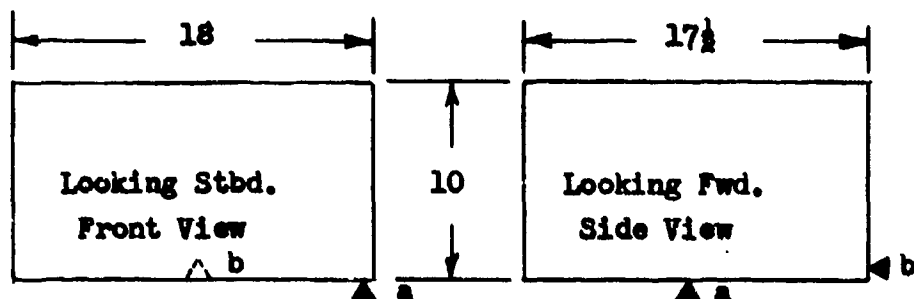
Gage DD403 #1	a	b	c	d	e	f
Baker	0.04	0.16	0.13	0.04	0.15	0.19
	g	h				
	0.40	0.05				

Comments

See "General Discussion" for this ship.

DD403 #2 Gages:

Location: On Model BCK Radio Receiver, Radio Transmitter Room, First Superstructure Deck. The unit is located on the starboard side above the TDQ.



Type of Mounting: L type mounts are under on the four bottom corners.

Photograph: AA CR 140-2293-1 and AA CR 140-2293-8

Deflection (inches):

Gage DD403 #2	a	b
Baker	0.12	0.10

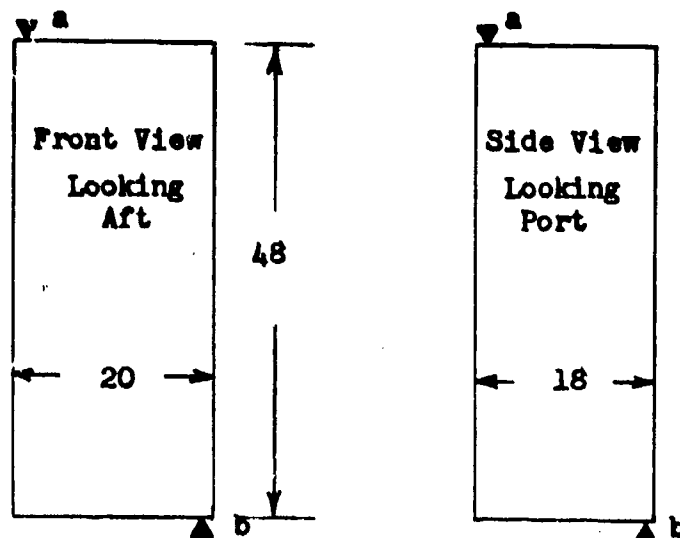
The deflection is about equal to the clearance.

Comments

See "General Discussion" for this ship.

DD403 #3 Gages:

Location: On Radar Transmitter Model SC-3, in Radar Transmitter Room, Second Superstructure Deck. The transmitter is in the aft end of the room.



Type of Mounting: Eight C type mounts equally spaced around the bottom edges. Two C type mounts on two upper back corners.

Photograph: AA CR 140-2292-10, 11, 12.

Deflection (inches):

Gage DD403 #3	a	b
Baker	0.33	0.25*

*Probably bottomed.

Comments

See "General Discussion" for this ship.

DD403 #4 Gages:

Location: On Range and Train Indicator Model SG, in C.I.C. Room, Aft Port Side, Second Superstructure Deck.

Type of Mounting: The long C type mounts, equally spaced across the bottom, run the full depth of the equipment. Clearance over 3/8 inch.

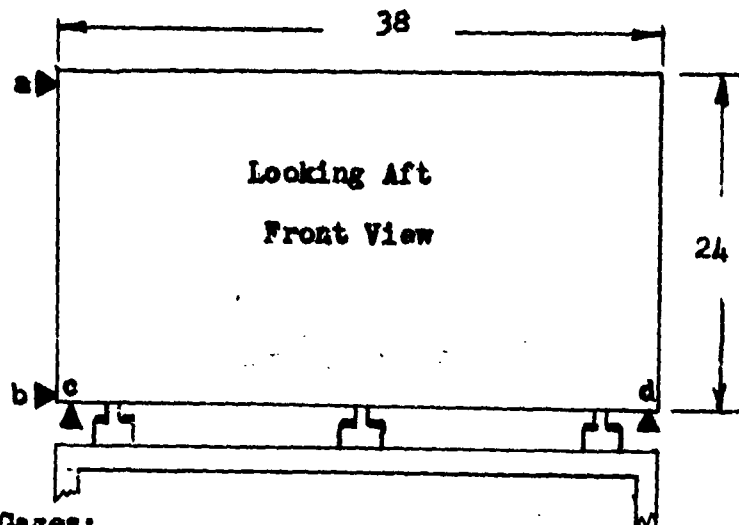
Photograph: AA CR 140-2295-5, 6, 7, 9.

Deflection (inches):

Gages DD403 #4	a	b	c	d
Baker	0.11	0.03	0.21	0.23

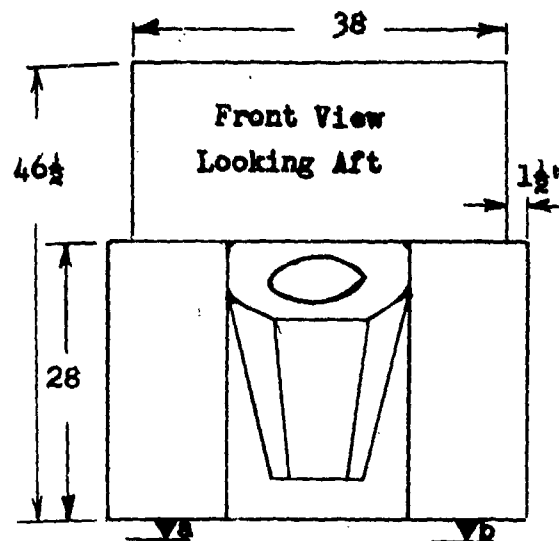
Comments

See "General Discussion" for this ship.



DDAO3 #5 Gages:

Location: On Plan Position Indicator, type CG, in C.I.C. Room, Aft Starboard Side, Second Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners. L type mounts in back upper corners of main unit.

Photograph: AA CR 140-2292-2, 3, 4.

Deflection (inches):

Gage DD403 #5

Baker

a	b
0.26*	0.23

*Probably bottomed.

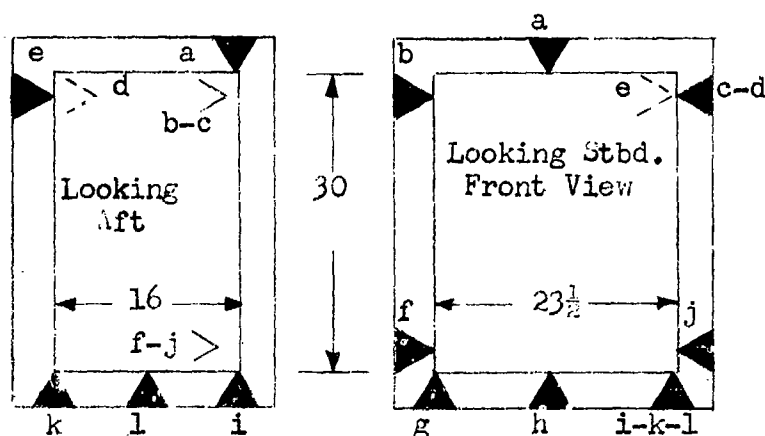
DD403 General Discussion

Baker: The ship was beyond the effective damaging range of the bomb. While no appreciable damage occurred, the shock mounts bottomed in many cases.

DD404 RHIND

DD404 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Central Transmitter Room, First Superstructure Deck. (Starboard side of forward interior bulkhead.)



Type of Mounting: Unit is mounted in an angle iron frame. C type mounts are at each of the four bottom corners. Vertical clearance is slightly greater than 1/4 inch.

Photograph: BA CR 95-791-7 and BA CR 95-791-8

Vibration Modes:

Rocking Fore and Aft	6.7 cps
Rocking Aftwardship	4.5
Translation Vertical	12.3

Deflection (inches):

Gage DD404 #1	a	b	c	d	e	f	g
Able	---	0.50	0.50	0.31	1.50*	0.13	0.34
		h	i	j	k	l	
		0.38	0.40	0.05	0.36	---	

*Hard bottom on gage base.

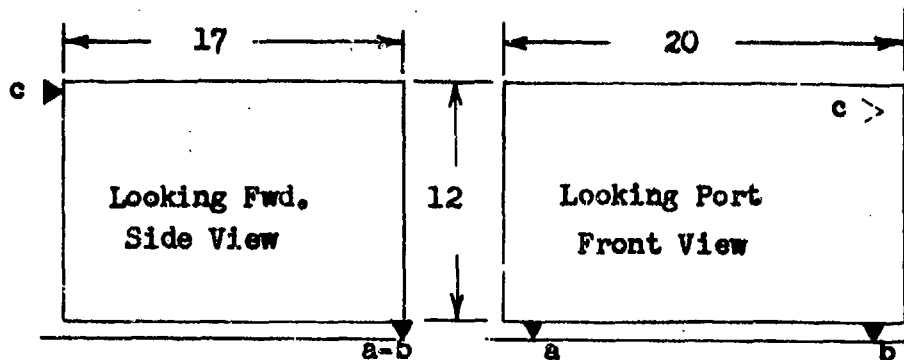
Comments

Able: The starboard side of the transmitter room was pushed in about 3 inches. In spite of the bottoming of the mounts and the collisions of the unit with the angle iron framing, the TDQ appeared to be in good condition and to key properly. A near by transmitter.

properly. A near by transmitter model TBK had a tube broken and did not key properly.
Baker: No data was obtained for this unit.

DD404 #2 Gages:

Location: On Model BBC Radio Receiver, in Radio Central Receiving Room, First Superstructure Deck.



Type of Mounting: L type mount under each of four bottom corners. Clearance is about 1/4 inch.

Photograph: BA CR 95-791-9

Vibration Modes:

Rocking Fore and Aft	10.6 cps
Rocking Athwartship	8.9
Translation Vertical	11.5

Deflection (inches):

Gage DD404 #2	a	b	c
Able	0.36	0.38	0.42
Baker	0.09	0.11	0.19

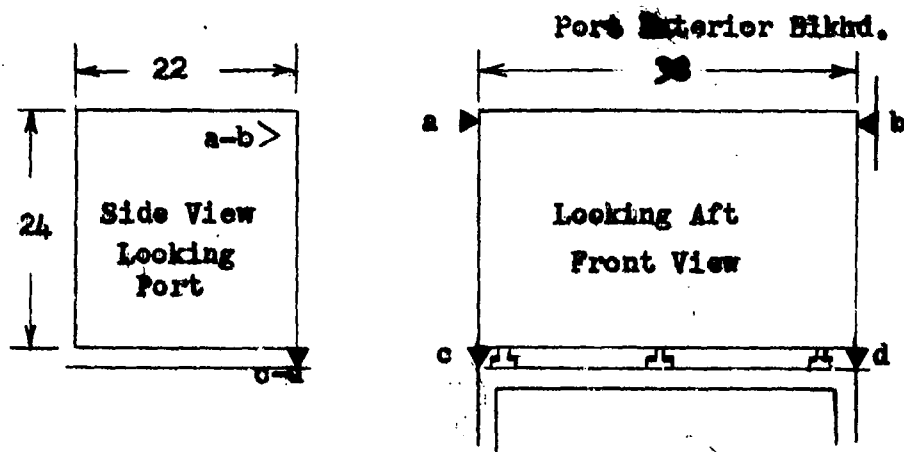
Comments

Able: The mounts bottomed, but the receiver remained in operable condition.

Baker: The shock intensity was negligible.

DD404 #3 Gages:

Location: On Range and Train Indicator, in C.I.C. Room,
Second Superstructure Deck.



Type of Mounting: Three C type mounts on bottom that extend the full length of equipment. Clearance 1/2 inch.

Vibration Modes:

Rocking Fore and Aft	7.3 cps
Rocking Athwartship	8.2

Deflection (inches):

Gage DD404 #3	a	b	c	d
Able	1.50*	0.75	0.25	0.13
Baker	0.21	0.80	0.10	—

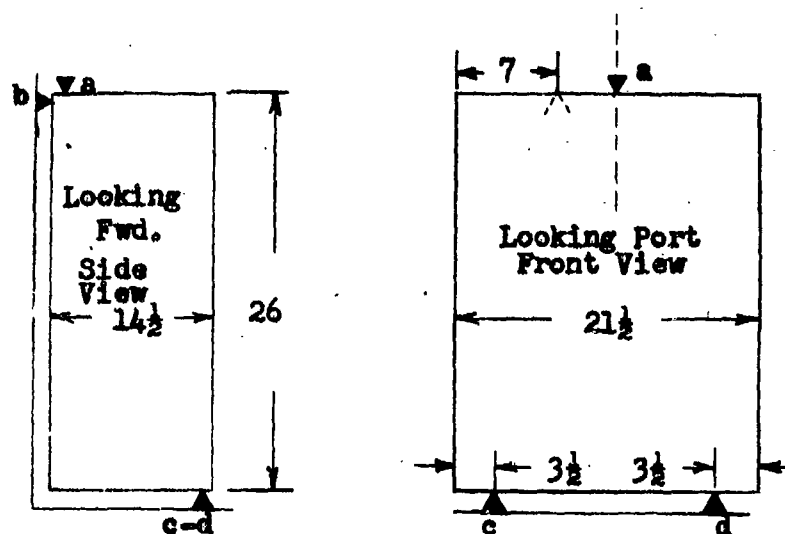
Comments

Able: The entire starboard side of the C.I.C. room was broken open by the blast. The Range and Train Indicator, which was located in the after port side of the room, suffered a considerable horizontal shock, but little vertically. The unit appeared to be in good condition.

Baker: The intensity of shock caused by Baker test was negligible.

DD404 #4 Gages:

Location: On High Voltage Rectifier type CW-20280, in
Rear Transmitter Room. Second Superstructure Deck.



Type of Mounting: L type mounts on each bottom corner and on two upper back corners.

Photograph: BA CR 95-791-11

Vibration Modes:

Rocking Athwartship 13.1 cps
(Other modes were much higher and not obtainable)

Deflection (inches):

Gage DD404 #4	a	b*	c	d
Able	0.12	---	0.17	0.18
Baker	0.05	---	0.05	0.06

*Gage knocked off.

Comments

Able: Although the mounts bottomed the intensity of shock did not appear severe. There was no apparent damage to the unit.

Baker: The shock intensity caused by Baker test was negligible.

DDA-04 General Discussion

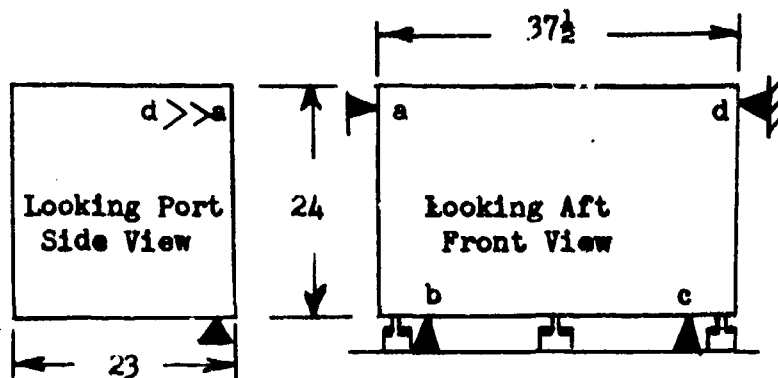
Able: All antenna systems were swept away by the Able blast. Although the blast permanently deformed and broke open some of the bulkheads of compartments containing shock mounted gear there was no evidence of more than moderate intensities of shock.

Baker: The ship was too far removed from the bomb to suffer any appreciable shock damage.

DD406 STACK

DD406 #1 Gages:

Location: On Range and Train Indicator Model SG, in
C.I.C. Room, Second Superstructure Deck. (Port Aft Side.)



Type of Mounting: Three long C type mounts run full depth across
the bottom of the equipment. Clearance 1/2 inch.

Photograph: BA CR 95-791-2

Vibration Modes:

Rocking Fore and Aft	20.8 cps
Rocking Athwartship	10.9

Deflection (inches):

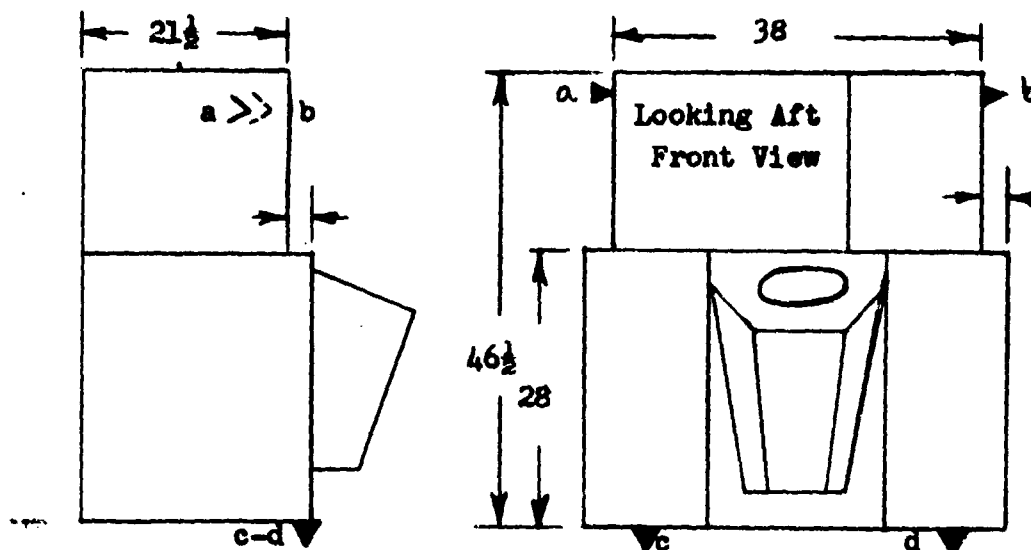
Gage DD406 #1	a	b	c	d
Able	0.50	0.09	0.09	0.94
Baker	0.23	0.04	0.07	0.85

Comments

See "General Discussion" for this ship.

DD406 #2 Gages:

Location: On Plan Position Indicator type CG, Starboard Aft Side of C.I.C. Room, on Second Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners with L type mounts in back upper corners of lower unit. Clearance about 1/4 inch in vertical direction for bottom mounts.

Photograph: BA CR 95-791-3

Vibration Modes:

Rocking Fore and Aft	5.74 cps
Rocking Athwartship	6.53

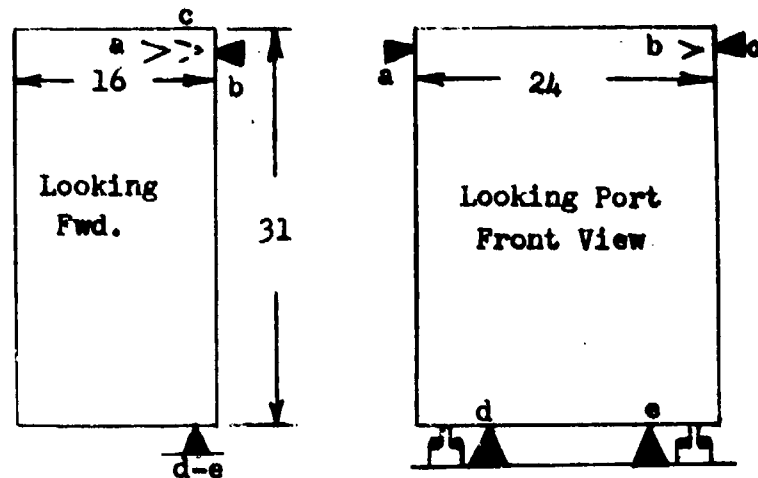
Deflection (inches):

Gage DD406 #2	a	b	c	d
Able	— *	0.60	0.17	0.09
Baker	0.43	0.43	0.09	0.07

*Bulkhead stiffener next to the a gage was bent in about 3 inches crushing the gage and its support. This stiffener was on a starboard exterior bulkhead. The compartment was undamaged except for the above mentioned distortion.

DD406 #3 Gages:

Location: On Radio Transmitter Model TDQ, in Radio Transmitter Room on Second Superstructure Deck.



Type of Mounting: C type mounts are used on each of four bottom corners. Clearance about 1/4 inch.

Photograph: BA CR 95-791-6

Vibration Modes:

Rocking Fore and Aft	7.6 cps
Rocking Athwartship	4.3
Translation Vertical	11.8 (estimate)

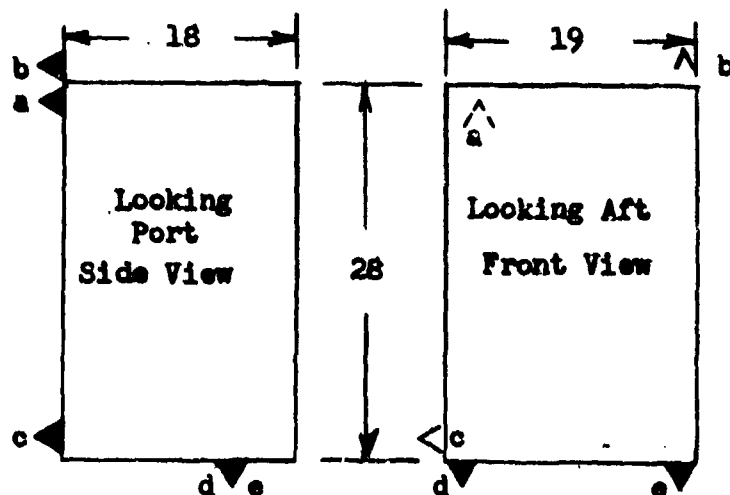
Deflection (inches):

Gage DD406 #3	a	b	c	d	e
Able	0.30	1.4*	0.42	0.23	0.25
Baker	0.10	1.0*	0.16	0.21	0.25

*Gages crushed to full length.
The mounts bottomed.
Compartment and equipment not damaged.

DD 406 #4 Gages:

Location: On Radio Transmitter Receiver type CFN, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: L type mounts are on the four bottom corners.
Clearance 1/8 to 1/4 inch to shoulder.

Photograph: BA CR 95-791-4

Vibration Modes:

Looking Fore and Aft	5.5 cps
Looking Athwartship	5.9
Translation Vertical	15.3

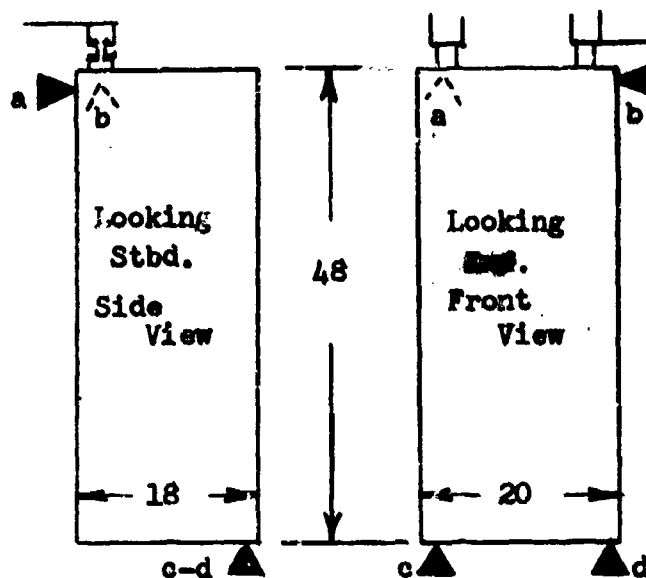
Deflection (inches):

Gages DD406 #4	a	b	c	d	e
Able	0.30	0.30	0.07	0.34	0.22
Baker	0.07	0.10	0.05	0.10	0.17

No apparent damage to compartment.

DD406 #5 Gages:

Location: On Radar Transmitter Model SC2, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: Eight C type mounts are located on the bottom corners and edges. Two C mounts are located on the upper back corner. There is about 1/4 inch vertical clearance.

Photograph: BA CR 95-791-5

Vibration Modes:

Rocking Fore and Aft	10.9 cps
Rocking Athwartship	8.8
Translation Vertical	10.9

Deflection (inches):

Gage DD406 #5	a	b	c	d
Able	0.17	0.34	0.05	0.0
Baker	0.12	0.17	0.10	0.10

DD406 General Discussion

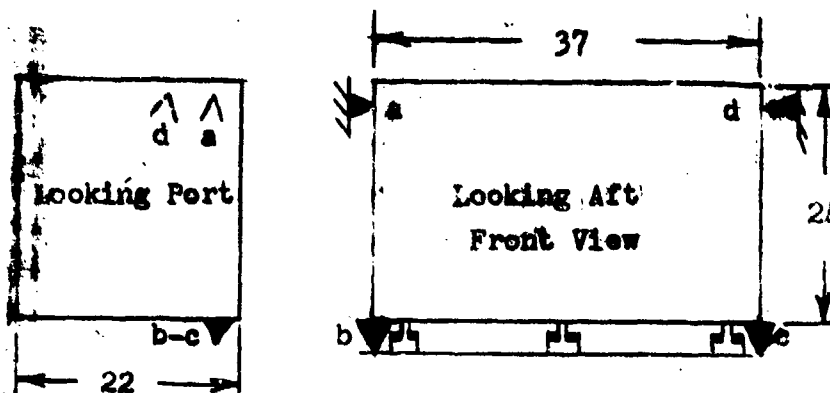
Able: The blast was sufficiently severe to slightly deform some of the exposed bulkheads of the radio compartments. However, the shock intensity was not great. No mounts failed although there was considerable bottoming. In general the electronic gear was not damaged.

Baker: The intensity of shock caused by Baker test was less than that caused by Able for this ship. No damage and little bottoming occurred.

DD408 WILSON

DD408 #1 Gages:

Location: On Range and Train Indicator type CRP in C.I.C. Room, Second Superstructure Deck (Aft port side of room).



Type of Mounting: Three C type mounts, as shown, extend full depth of equipment. Clearance before bottoming is about 1/4 inch.

Photograph: BA CR 95-789-3

Vibration Modes:

Rocking Fore and Aft	7.6 cps
Rocking Athwartship	10.2

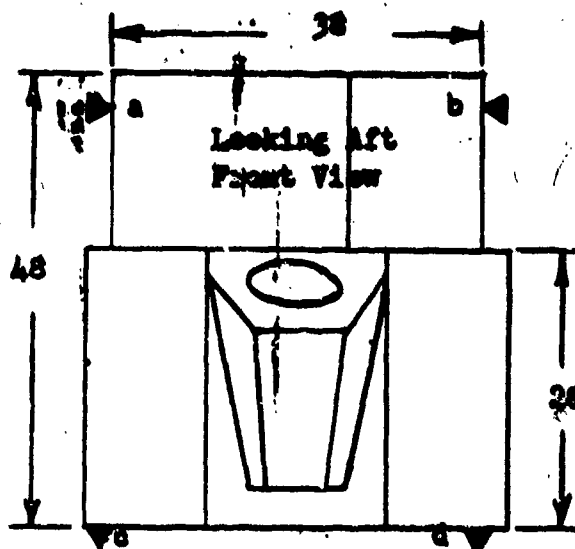
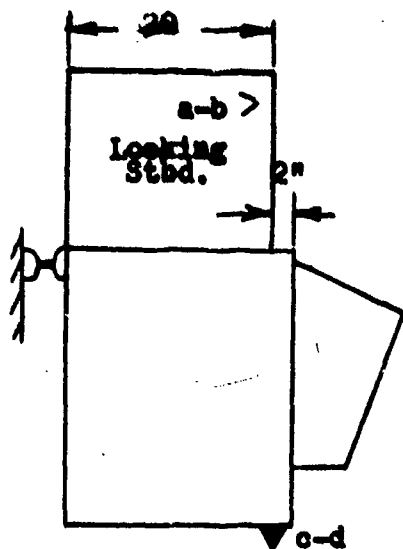
Deflection (inches):

Gage DD408 #1	a	b	c	d
Able	0.36	0.09	0.10	0.17
Baker	0.32	0.05	0.16	0.46

The starboard bulkhead was pushed in several inches by the Able shot, otherwise there was no observable damage.

DD408 #2 Gages:

Location: On Plan Position Indicator type CG, in C.I.C. Room, Second Superstructure Deck (starboard aft corner of the room).



Type of Mounting: Short C type mounts under each bottom corner, and L type mounts in back upper corners of the lower unit. Clearance to bottom about 1/4 inch.

Photograph: DA CR 95-789-4

Vibration Modes:

Rocking Fore and Aft	5.6 cps
Rocking Athwartship	5.7

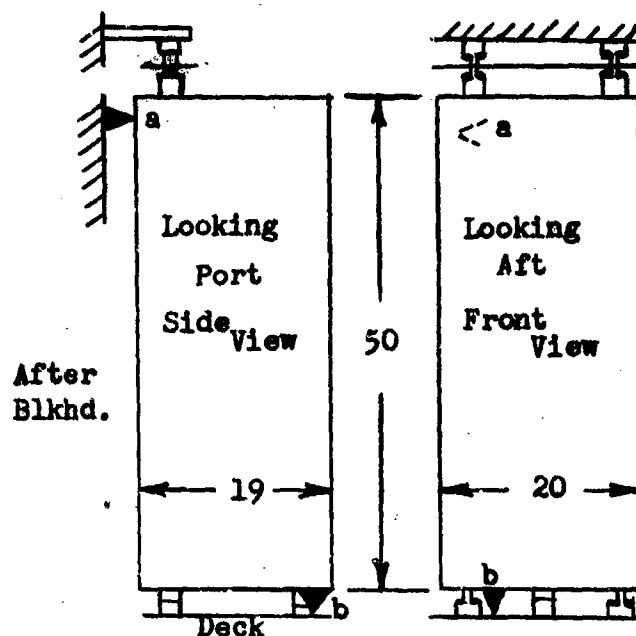
Deflection (inches):

Gage DD428 #2	a	b	c	d
Able	1.2*	0.7	0.12	0.15
Baker	0.5	0.5	0.13	0.11

*This deflection was mostly due to the displacement of the starboard exterior bulkhead to which it was fastened; the permanent displacement of this bulkhead at this point was about 1 inch.

DD428 #3 Gages:

Location: On Radar Transmitter Model SC-3, in Radar Transmitter Room, Second Superstructure Deck (located near center of Aft bulkhead).



Type of Mounting: Six short C type mounts under base plus two head braces on upper back edge. Clearance is about 1/4 inch before mounts bottom.

Photograph: BA CR 95-790-3

Vibration Modes:

Rocking Fore and Aft	9.2 cps
Rocking Athwartship	8.8

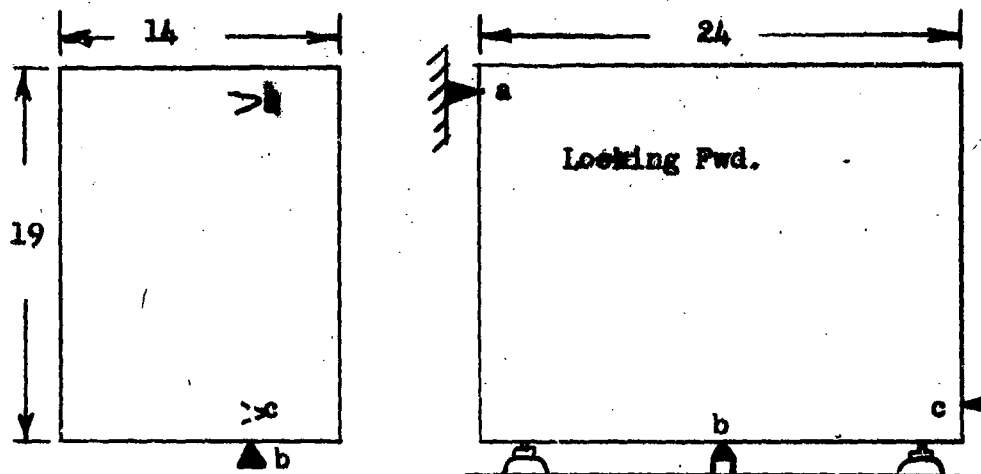
Deflection (inches):

Gage DD408 #3	a	b
Able	0.18	0.09
Baker	0.19	0.16

No noticeable damage for either test. The deflections are less than would be caused by a sustained acceleration of 2 g.

DD408 #4 Gages:

Location: On Auto-Dryaire Model 2200, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: L type mounts on four bottom corners. About 0.20 inches clearance before bottoming on shoulder of mount.

Photograph: BA CR 95-790-4

Vibration Modes:

Rocking Fore and Aft	8.2 cps
Rocking Athwartship	11.8
Translation Vertical	17.0

Deflection (inches):

Gage DD408 #4

	a	b	c
Able	0.21	0.17	0.17
Baker	0.46	0.14	0.15

DD408 #5 Gages:

Location: On Model TDQ Radio Transmitter, in Main Radio Transmitter Room, First Superstructure Deck. (In forward starboard corner.)

Type of Mounting: C type mounts under each bottom corner. Clearance about 0.2 inches before bottoming.

Photograph: BA CR 95-789-1

Vibration Modes:

Rocking Fore and Aft	4.1 cps
Rocking Athwartship	6.8
Translation Vertical	12.0 (estimate)

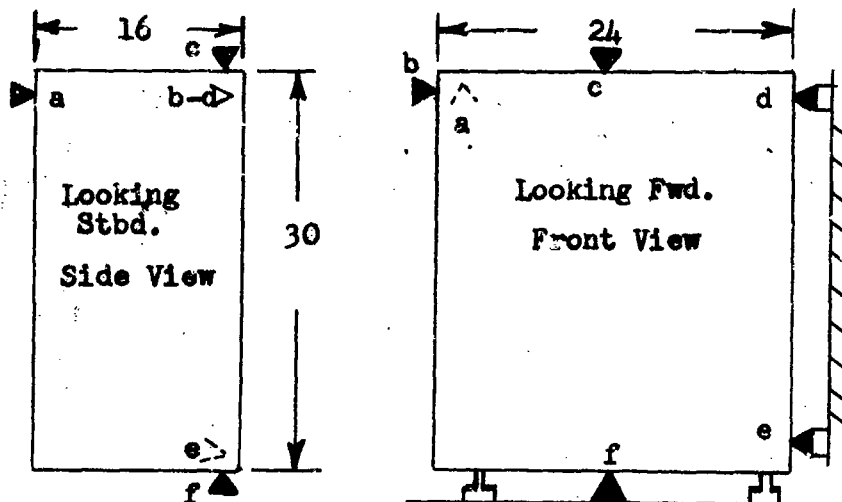
Deflection (inches):

Gage DD408 #5	a	b	c	d	e	f
Able	0.60	0.38	0.18	1.0*	0.60	0.15
Baker	0.21	0.24	0.17	0.37	0.41	0.10

*Bumped against base of gage.

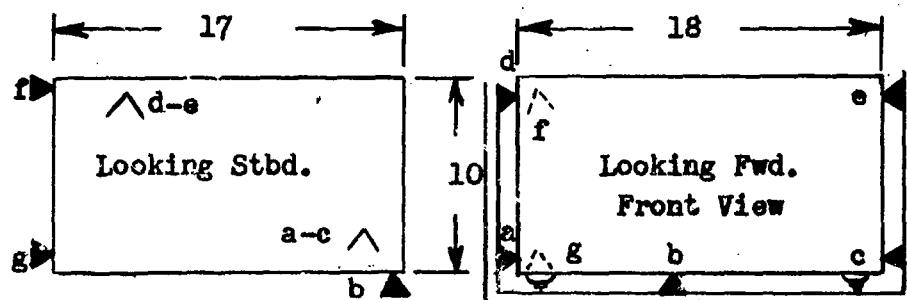
Door casing to compartment was bent in several inches by Able blast.

Radio and radar equipment are in good condition.



DD408 #6 Gages:

Location: On Model RCK Radio Receiver, of Forward Starboard Corner, in Main Radio Transmitter Room, First Superstructure Deck.



Type of Mounting: L type mounts on four bottom corners.
Clearance $1/8$ to $1/4$ inches to shoulder of mounting.

Photograph: RA CR 95-788-12, RA CR 95-789-2

Vibration Modes:

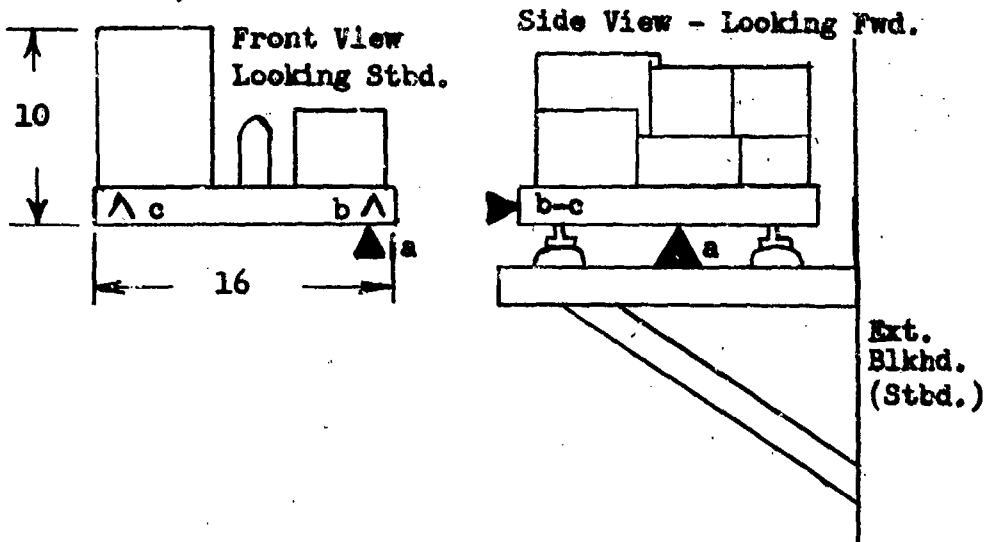
Rocking Fore and Aft	7.7 cps
Rocking Athwartship	9.6
Translation Vertical	12.1

Deflection (inches):

Gage DD408 #6	a	b	c	d	e	f	g
Able	0.08	0.13	0.08	0.10	0.26	0.10	0.09
Baker	0.07	0.10	0.06	0.13	0.18	0.10	0.08

DD408 #7 Gages:

Location: On Power Pack, in Radio Receiving Room, First Superstructure Deck.



Type Of Mounting: L type mounts under four bottom corners.
Clearance to shoulders of mounts about $1/8$ inch.

Photograph: RA CR 95-788-11

Vibration Modes:

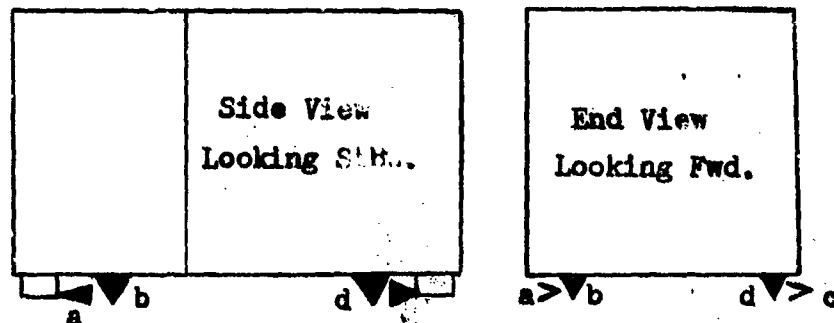
Rocking Fore and Aft	13.3 cps
Rocking Athwartship	11.6
Translation Vertical	12.2

Deflection (inches):

Gage DD408 #7	a	b	c
Able	0.32	0.28	0.14
Baker	0.08	0.05	0.03

DD408 #8 Gages:

Location: On Emergency Diesel Generator, in Compartment A-206-E (frame 56, deck below main deck).



Type of Mounting: Rubber mounts in compression. Less than 1/8 inch clearance laterally.

Photograph: BA CR 140-400-4, 5

Deflection (inches):

Gages DD408 #8	a	b	c	d
Able	0.03	0.02	0.02	0.03
Baker	0.09	0.09	0.0	—

The diesel generator was quite rigidly mounted. No knowledge was obtained of the detailed properties of its supports. No damage was suffered by the equipment.

DD408 General Discussion

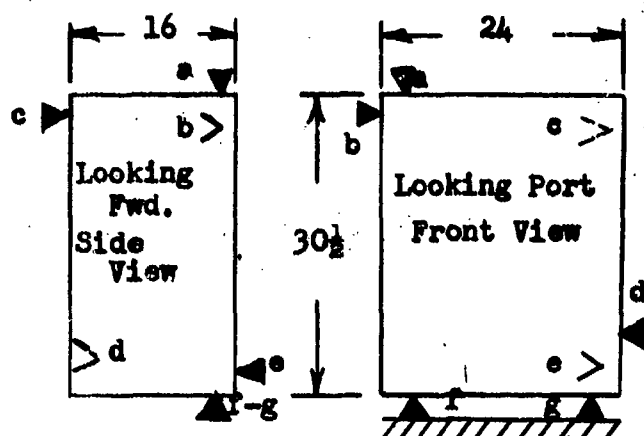
Able: The blast pushed in for several inches some of the starboard bulkheads of the radio and radar compartments. The shock intensity, however, was not great. There were no shock mount failures, although there was some bottoming, and, the equipment generally remained in operable condition. The overall damage to the ship was slight.

Baker: There was no appreciable damage caused by the Baker test. The effect of the Able and Baker shocks on the gear considered was about the same for the two conditions.

DD410 MOUNTS

DD410 #1 Series:

Location: On Model TDQ Radio Transmitter, in Radio Transmitter Room (forward port corner near exterior bulkhead), First Superstructure Deck.



Type of Mounting: C type mounts on four bottom corners.
Clearance about 1/4 inch.

Photograph: BA CR 95-737-6

Vibration Modes:

Rocking Fore and Aft	4.4 cps
Rocking Athwartship	6.8
Translation Vertical	11.7

Deflection (inches):

Gage DD410 #1	a	b	c	d	e	f	g
Able	0.21	0.15	0.80	0.07	0.07	0.23	0.21
Baker	Room badly damaged by Baker, no readings possible.						

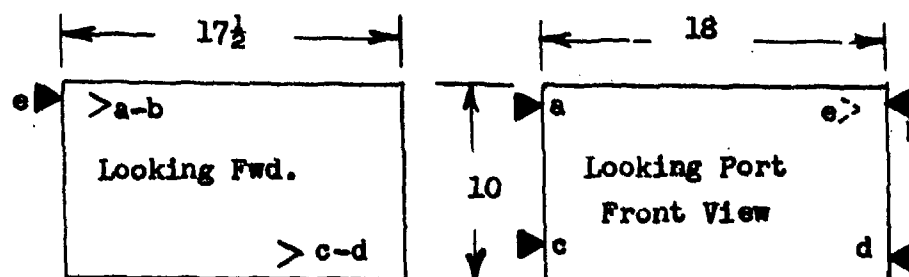
Comments

Able: There was negligible shock or damage caused by test Able.

Baker: The shock caused by Baker test was of great severity. The transmitter room and its contents were in such disorder that no quantitative measurements were possible.

DD410 #2 Gages:

Location: On Model RCK Radio Receiver, in Radio Transmitter Room, First Superstructure Deck. (In Forward Port Corner above TDQ.)



Type of Mounting: L type mounts on four bottom corners. Clearance to shoulders of mounts is 1/8 inch.

Photograph: BA CR 95-737-7

Vibration Modes:

Rocking Fore and Aft	9.3 cps
Rocking Athwartship	8.3
Translation Vertical	11.8

Deflection (inches):

Gage DD410 #2	a	b	c	d	e
Able	0.13	0.23	0.09	0.09	0.25
Baker	Room badly damaged by Baker test, no readings possible.				

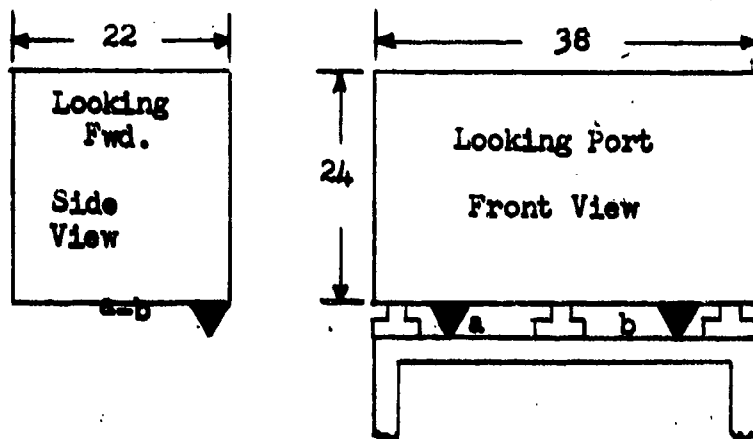
Comments

Able: There was negligible shock or damage caused by test Able.

Baker: The transmitter room and its contents were put in such disorder by the Baker test that no readings were possible.

DD410 #3 Gages:

Location: On Range and Train Indicator type CRP-55ABC-3
Room, Second Superstructure Deck (port side).



Type of Mounting: Three C type mounts, as shown, run the full depth of the equipment. Clearance is about 1/2 inch.

Photograph: BA CR 95-737-8

Vibration Modes:

Rocking Fore and Aft	6.6 cps
Rocking Athwartship	9.1

Deflection (inches):

Gage DD410 #3	a	b
Able	0.30	0.24
Baker	--*	0.63

*Gage broke off

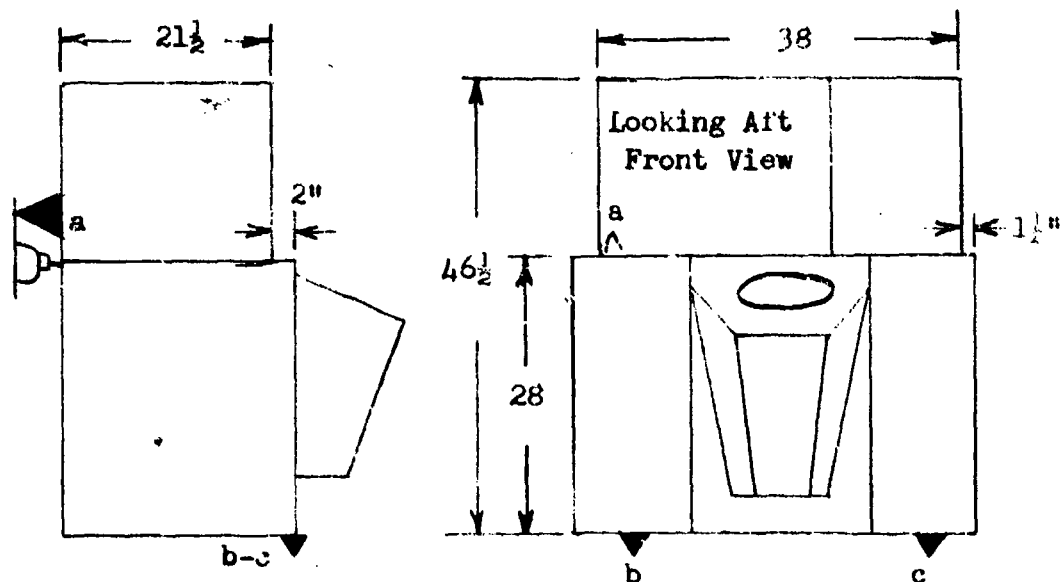
Comments

Able: There was negligible shock or shock damage caused by test Able.

Baker: The shock caused by Baker test was very severe. The mounts did not fail although they were not stiff enough to be effective.

DD410 #4 Gages:

Location: On Plan Position Indicator type CG, in C.I.C.
Room (after starboard corner), Second Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners. L type mounts on the back upper corners of the lower unit. Clearance from 1/4 to 3/8 inch before mounts bottom.

Photograph: BA CR 95-737-9

Vibration Modes:

Rocking Fore and Aft	4.5 cps
Rocking Athwartship	5.0

Deflection (inches):

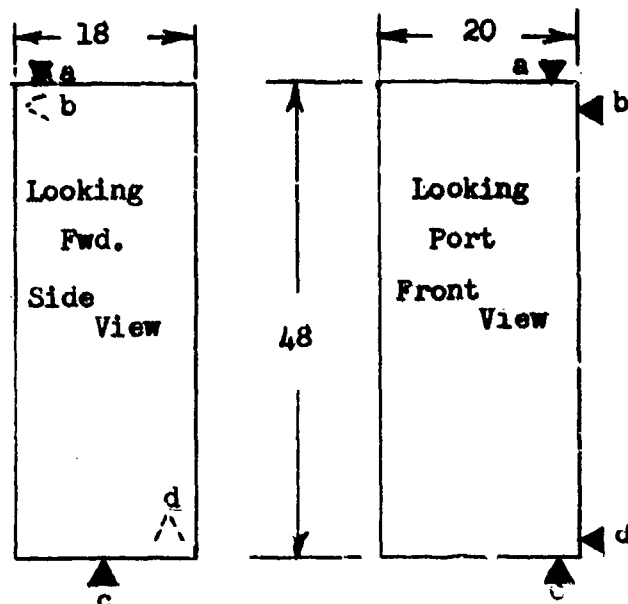
Gages DD410 #4	a	b	c
Able	0.55	0.21	0.09
Baker	--	--	--

Comments

Able: The deflections caused by test Able were small.
Baker: The unit was knocked entirely free of its supports during test Baker. All mounts on the base of the equipment failed. The upper rear mounts pulled a bulkhead "T" section loose.

DD410 #5 Gages:

Location: On Radar Transmitter Model SC-2, type CG, in Radar Transmitter Room, Second Superstructure Deck.



Type of Mounting: Short C type mounts on four bottom corners and in middle of front and back bottom edges. C type mounts on upper back corners. Vertical clearance less than 1/8 inch (rubber had crept).

Photograph: BA CR 95-737-10

Vibration Modes:

Rocking Fore and Aft	7.2 cps
Rocking Athwartship	7.3
Translation Vertical	7.4

Deflection (inches):

Gages DD410 #5	a	b	c	d
Able	0.21	0.25	0.09	0.11
Baker	--	--	--	--

Comments

Able: Only small deflections and no damage were caused by test Able.

Baker: All of the mounts failed for test Baker, allowing the gear to become loose. The compartment was wrecked.

DD410 General Discussion

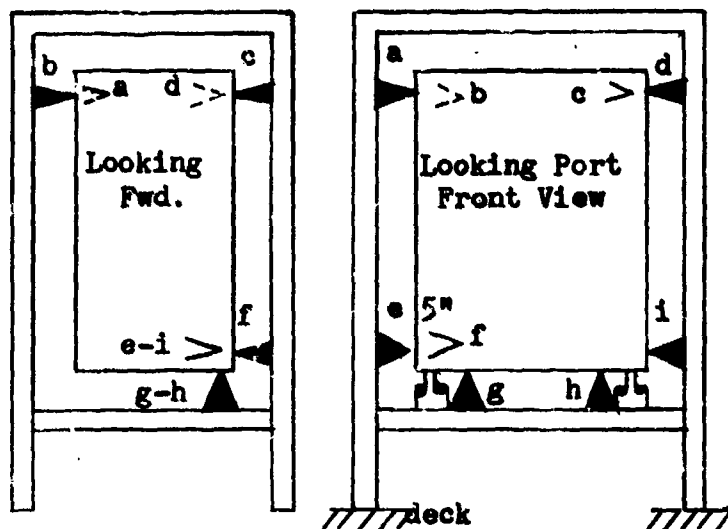
Able: There was no appreciable damage and shock caused to this ship by test Able.

Baker: The ship was severely damaged by test Baker. Considerable flooding and machinery damage occurred. Shock damage to electrical equipment was especially extensive in the lower parts of the ship. The shock experienced by equipment should be regarded as of an intensity slightly less than that which would cause uncontrollable flooding throughout the major part of the ship with a crew present. Watertight integrity was affected principally by the rupture of piping and fracture of sea connections and was not caused by extensive hull failure. It is probable that properly mounted and constructed electrical and electronic gear could withstand the shock existing in the upper parts of the ship. It is apparent that the failure of the machinery items in the lower parts of the ship point to much more attention to be required for their more rugged construction. It is believed that the shock intensity in this case represents a near maximum for which protection is required.

DD419 WAINWRIGHT

DD419 #1 Gages:

Location: On Radio Transmitter Model TDQ, in Forward Port Corner of Radio Transmitter Room, First Superstructure Deck.



Type of Mounting: Short C type mounts on each of four bottom corners. Clearance of mount is about 1/4 inch vertically.

Photographs: BA CR 95-788-6 and BA CR 95-788-8

Vibration Modes:

Rocking Fore and Aft	5 cps
Rocking Athwartship	7.4
Translation Vertical	11.9

Deflection (inches):

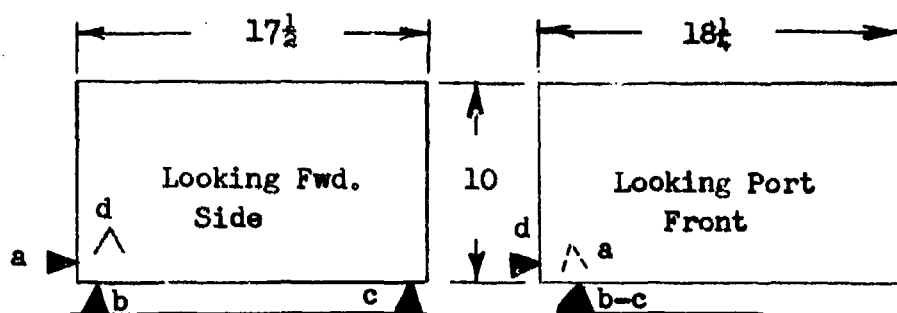
Gage DD419 #1	a	b	c	d	e	f	g
Able	0.05	0.46	0.34	0.13	0.05	0.03	0.11
Baker	0.07	0.73	0.50	0.05	0.00	0.03	0.16
	h	i					
	0.11	0.00					
	0.16	0.00					

Comments

See "General Discussion" for this ship.

DD419 #2 Gages:

Location: On Model RCK Radio Receiver, in Forward Port Corner of Radio Transmitter Room, First Superstructure Deck.



Type of Mounting: L type mounts on four bottom corners. Vertical clearance is about 1/8 inch to shoulder of mount.

Photographs: BA CR 95-788-9 and BA CR 95-788-10

Vibration Modes:

Rocking Fore and Aft	10.7 cps
Rocking Athwartship	14.5
Translation Vertical	16.3

Deflection (inches):

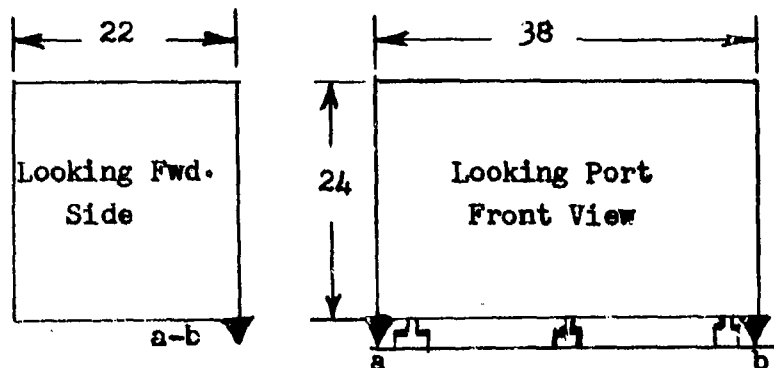
Gage DD419 #2	a	b	c	d
Able	0.01	0.07	0.07	0.01
Baker	0.03	0.06	0.08	0.00

Comments

See "General Discussion" for this ship.

DD419 #3 Gages:

Location: On Range and Train Indicator Model SG, in Aft Port Corner of C.I.C. Room, Second Superstructure Deck.



Type of Mounting: Three long C type mounts, spaced as shown, extend across the full depth of equipment. Vertical clearance of mount is about 1/2 inch.

Photograph: BA CR 95-782-5

Vibration Modes:

Rocking Fore and Aft	20 cps
Rocking Athwartship	8.4

Deflection (inches):

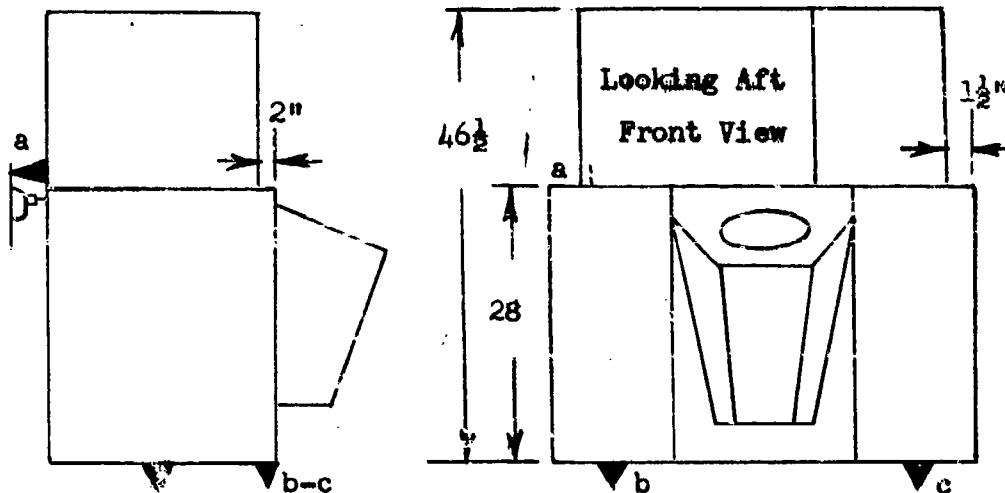
Gage DD419 #3	a	b
Able	0.13	0.11
Baker	0.07	0.07

Comments

See "General Discussion" for this ship.

DD419 #4 Gages:

Location: On Plan Position Indicator type CG, on After Starboard Side of C.I.C. Room, Second Superstructure Deck.



Type of Mounting: Short C type mounts on each four bottom corners. L type mounts in back upper corners of lower unit. Vertical clearance is slightly over 1/4 inch for bottom mounts.

Photograph: BA CR 95-788-3 and BA CR 95-788-4

Vibration Modes:

Rocking Fore and Aft	4.4 cps
Rocking Athwartship	4.4

Deflection (inches):

Gage DD419 #4	a	b	c
Able	0.26	0.13	0.11
Baker	0.41	0.14	0.14

DD419 #5 Gages:

Location: On Radar Transmitter Model SC-3, on Forward Starboard Side of Radar Transmitter Room, Second Super-structure Deck.

Type of Mounting: Eight short C type mounts around bottom corners and edges, two C type mounts on upper back corners. Vertical clearance of mount is about 1/4 inch.

Photograph: BA CR 95-788-1 and BA CR 95-788-2

Vibration Modes:

Rocking Fore and Aft
Rocking Athwartship

8.1 cps
8.6

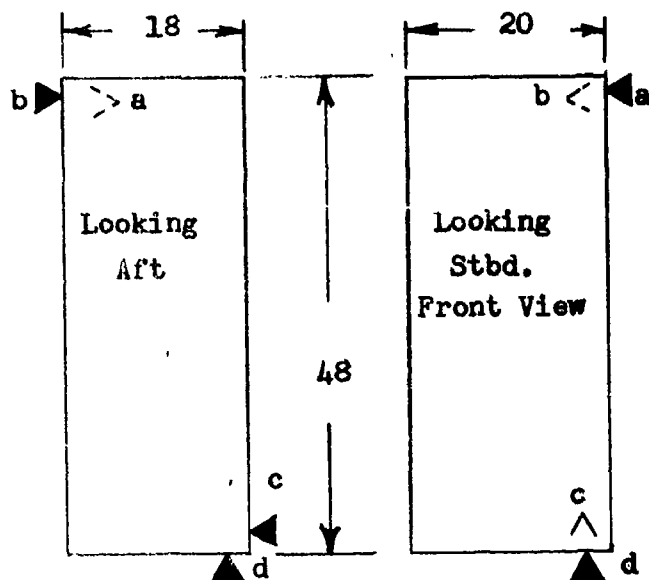
Deflection (inches):

Gages DD419 #5

Able

Baker

a	b	c	d
0.11	0.09	0.05	0.06
0.09	0.10	0.13	0.05



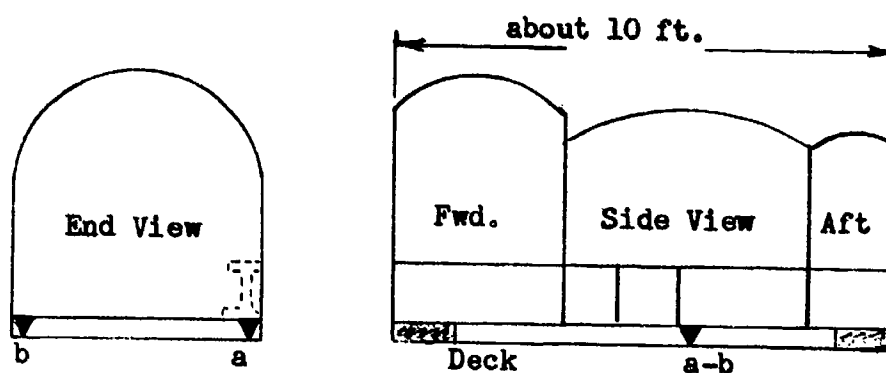
DD419 General Discussion

Able and Baker: There was negligible shock existant on this ship during tests Able and Baker.

APA64 BRACKEN

APA64 #1 Gages:

Location: On Turbo-Generator (BuShips Section 660 Special Item #11 #15), in Forward Cargo Hold Lowest Level.



Type of Mounting: The unit is solidly mounted at the four bottom corners, but it has a long unsupported span between its ends. The unit weighs about 15 tons.

Photograph: BA CR 140-1601-10 and BA CR 140-1601-9

Deflection (inches):

Gages APA64 #1	a	b
Able	0.00	0.00
Baker	0.00	0.05

Comments

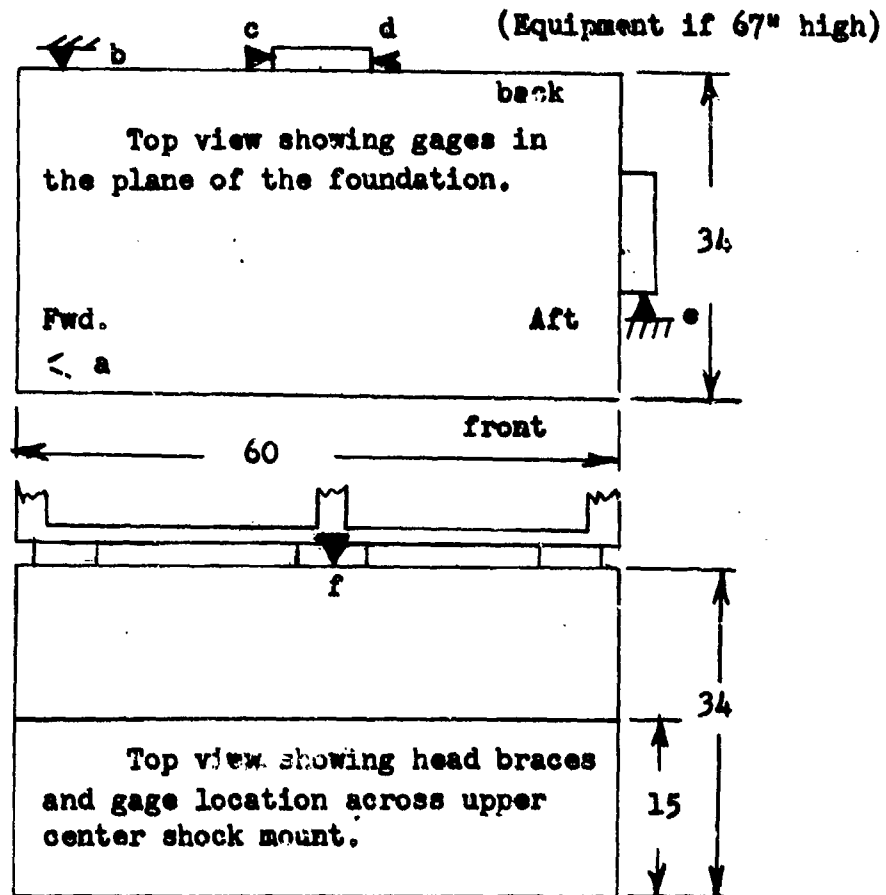
Able: There was no measurable deflection of the long unsupported span of the turbo-generator caused by the Able test.

Baker: The deformation of the above mentioned span by test Baker was negligible. The general shock throughout the ship was of a minor nature.

APA77 CRITTENDEN

APA77 #1 Gages:

Location: On Control Bench (Bulships Section 068 Item 12E5), at Starboard Side, Lowest Level, of Forward Cargo Hold.



Type of Mounting: Special built-in mounts using rubber in compression.

Photographs: BA CR 140-1602-1 and BA CR 140-1602-2
BA CR 140-1602-3 and BA CR 140-1602-4

Vibration Modes:

Rocking Fore and Aft	14.1 cps
Rocking Athwartship	11.2

Deflection (inches):

Gage APA77 #1	a	b	c	d	e	f
Able	0.17*	0.19*	0.11*	0.05*	0.12*	0.00*
Baker	0.05	0.02	0.08	0.30	0.00	0.03

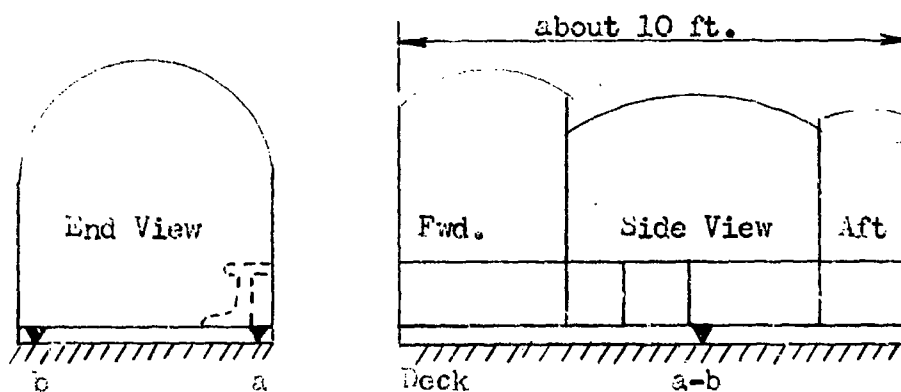
* Deflection believed caused almost entirely by the impact of falling hatch covers against the top of the unit.

Comments

Able: There was no evidence of shock other than that caused by the impacts of falling hatch covers.
Baker: Shock of a very minor nature at this location is indicated by the small deflections of the shock mounted control bench. There was no damage to this gear.

APA77 #2 Gages:

Location: On Turbo-Generator (BuShips Section 660 Special Item #12E1) in Forward Cargo Hold, Lowest Level.



Photograph: BA CR 140-1602-5

Deflection (inches):

Gage APA77 #2	a	b
Able	0.34	0.25
Baker	0.07	0.11

*The deflection for the Able test is believed caused by the impact of falling hatch covers striking the top of the unit.

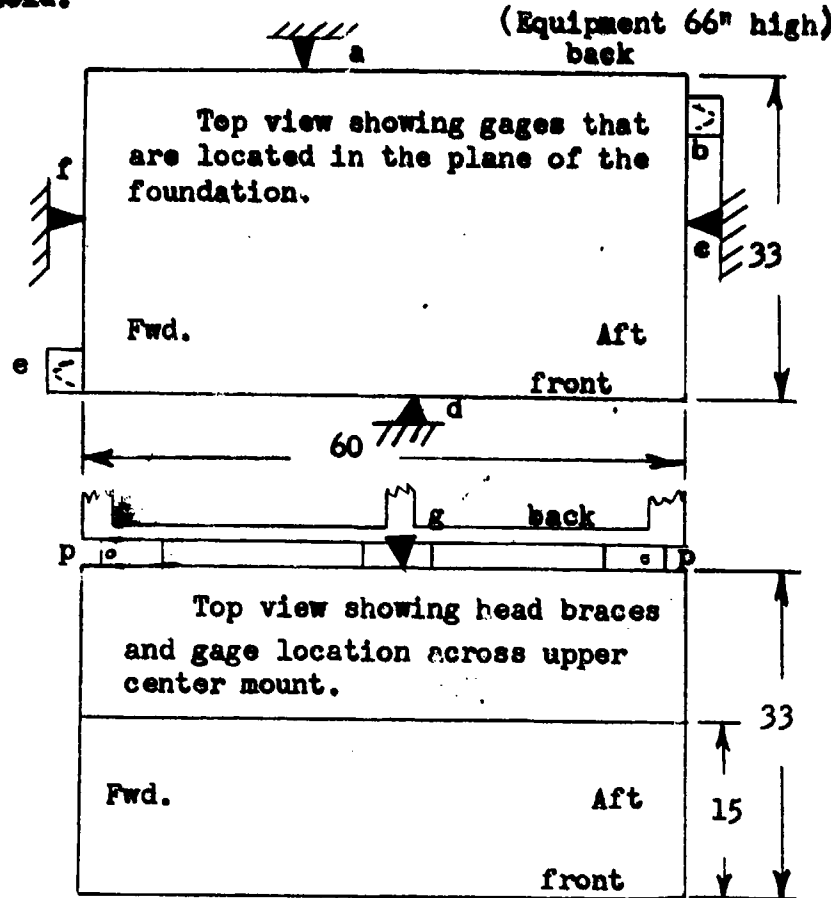
Comments

Able: Except for the damage caused by falling hatch covers there were no shock effects caused by Able test.
Baker: The deflection of the long unsupported span of the turbo-generator indicated minor shock intensities.

APA79 DAWSON

APA79 #1 Gages:

Location: On Control Bench (BuShips Section 660 Item 13E4) at Starboard Side, Second Platform Deck, in Forward Cargo Hold.



Type of Mounting: Special built-in mounts using rubber in compression.

Photographs: BA CR 140-1602-6 through 11

Vibration Modes:

Rocking Fore and Aft 13 cps
Shear pins prevented other modes of vibration

Deflection (inches):

Gage APA79 #1	a	b	c	d	e	f	g
Able	0.09	0.15	0.05	0.13	0.07	0.05	0.00
Baker	No readings obtained for Baker test.						

Comments

Able: The hatch cover collapsed into this hold and the overhead was bent down over the switchboard. However there was no damage from other causes at the switchboard location or to the switchboard caused by the Able test.

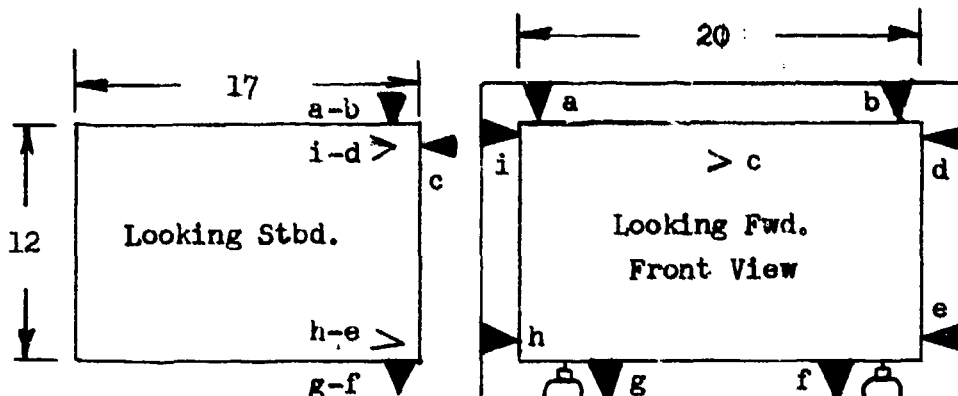
Baker: No data were obtained.

BB34 NEW YORK

There was no appreciable damage, caused by the ~~BB34~~ test, to any of the shock mounted equipment internal to the New York. The Baker test, however, resulted in a shock of reasonably severe intensity throughout the ship.

BB34 #1 Gages:

Location: On Model RDS Radio Receiver, in Forward Starboard Corner of Main Radio (Receiving) Room, Third Deck Interior Room between Frames 50-53.



Type of Mounting: L type mounts on the four bottom corners. Clearance is not apparent but is on the order of 3/8 to 1/2 inch. The unit is mounted in an angle iron frame that is attached to a forward interior bulkhead.

Photograph: BA CR 54-752-1

Vibration Modes:

Rocking Fore and Aft	9.1 cps
Rocking Athwartship	10.4
Translation Vertical	11.5

Deflection (inches):

Gage BB34 #1	a	b	c	d	e	f
Able	0.11	0.09	0.05	0.00	0.00	0.07
Baker	0.75*	0.75*	0.03	0.23	0.09	0.23
	g	h	i			
	0.11	0.01	0.07			
	0.19	0.09	0.21			

*Gage smashed flat.

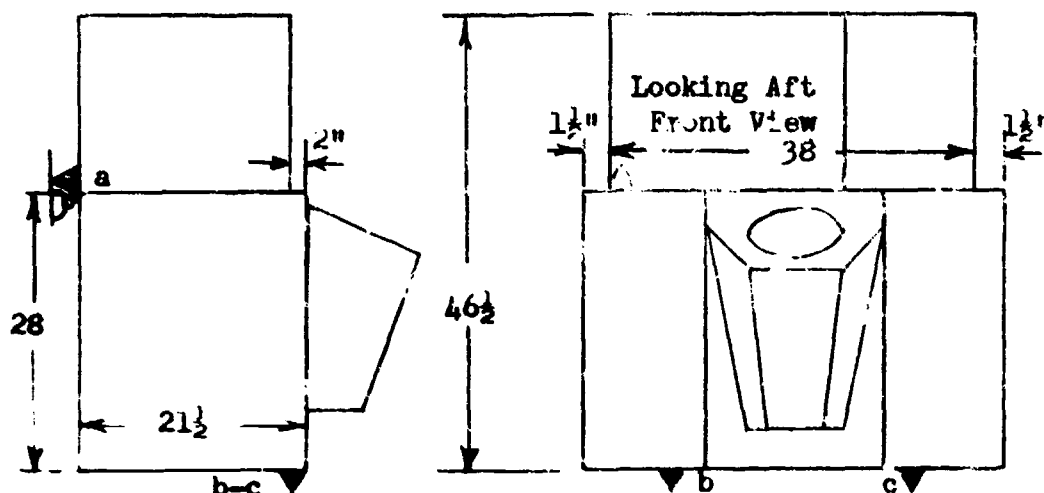
Comments

Able: The shock at this interior part of the ship was negligible. The deflections are generally less than would be caused by a sustained acceleration of $1g$.

Baker: The vertical component of the shock was severe causing $3/4$ inch upward motion and solid bottoming. However, there was no apparent damage to the receiver. The shock in the horizontal direction was negligible.

BH3A #2 Cages:

Location: On Plan Position Indicator, type CG, in Center of After Bulkhead of C.I.C. Room which is located on the Signal Bridge.



Type of Mounting: Short C type mounts on each four bottom corners. L type mounts on back upper corners of the lower unit. Clearance of mounts is between $1/4$ and $3/8$ inch.

Photograph: BA CR 54-752-3

Vibration Modes:

Rocking Fore and Aft
Rocking Athwartship

3 cps
4.2

Deflection (inches):

Gage BB34 #2

Able

Baker

a	b	c
0.15	0.15	0.15
-- *	-- *	-- *

*Equipment broke loose and moved about two feet forward.

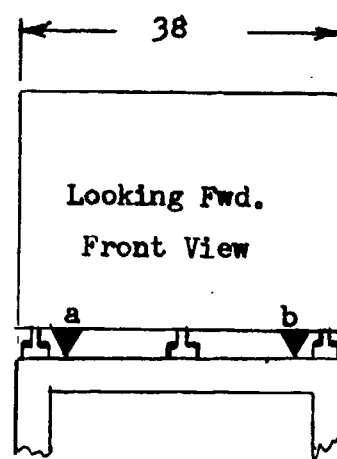
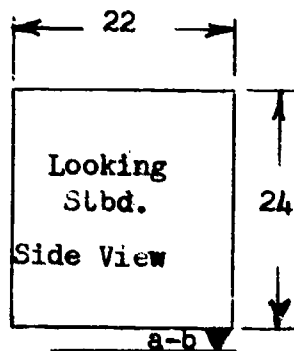
Comments

Able: There was no appreciable check.

Baker: The shock mounts failed and allowed equipment to come loose.

BB 34 #3 Gages:

Location: On Range and Train Indicator, type GNP-55 AFH, in Forward Port Corner of C.I.C. Room on Signal Bridge.



Type of Mounting: Three C type mounts run the full depth of the equipment as shown above. Vertical clearance of mounts is about 1/2 inch.

Photograph: BA CR 95-737-8

Vibration Modes:

Rocking Fore and Aft	7.6
Rocking Athwartship	8.4

Deflection (inches):

Gage BB34 #3

Able

Baker

a	b
0.11	0.15
0.48	0.34

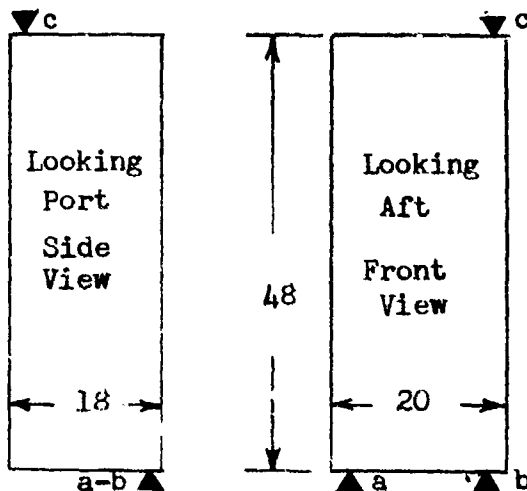
Comments:

Able: There was no appreciable shock.

Baker: It is probable that the apparatus bottomed, but with little excess energy. If it is assumed, as a reasonable approximation, that the frequency of vertical vibration is 10 cps, then at least 1/2 inch clearance is required. This is about 5 times the static deflection. The equipment was not obviously damaged.

BB34 #4 Gages:

Location: On Radar Transmitter Model SK type CG-52ABH, in #2 Combat (frame 64) on the Flag Bridge.



Type of Mounting: Eight C mounts used on the bottom corners and on edges midway between corners, two C type mounts on upper back corners.

Photograph: BA CR 54-752-5, BA CR 54-752-6, and BA CR 54-752-7

Vibration Modes:

Rocking Fore and Aft	6 cps
Rocking Athwartship	7.2
Translation Vertical	8.2

Deflection (inches):

Gage BB34 #4	a	b	c
Able	0.15	0.11	0.34
Baker	0.36	0.55	0.95

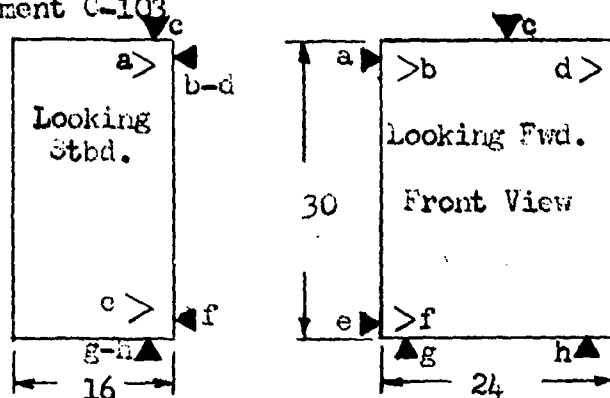
Comments

Able: There was no damage and negligible shock intensity registered by this equipment.

Baker: The mounting system was adequate to protect this radar from noticeable damage. However, the deflections were very large which indicated severe shock conditions.
Type of damage caused by Baker test to Combat #2 compartment is indicated by the failure of the bonding of the sheer mounts (holding the gyro repeater) the train indicator was thrown out of place; and the optical range finder was broken out of the saddle.

BB34 #5 Gages:

Location: On Radio Transmitter Model TD₄, in Forward Starboard Corner of Radio Transmitter Room, on the Third Deck, Compartment C-103.



Type of Mounting: Short C type mounts at bottom corners. Clearance to bottom mount is 1/2 inch. The unit is mounted in an angle iron frame.

Photograph: BA CR 95-742-1

Vibration Modes:

Rocking Fore and Aft 4.4 cps
Rocking athwartship 7.0

Deflection:

Gage BB34 #5	a	b	c	d	e	f	g	h
Able	.01	.09	.13	.07	.01	.01	.17	.19
Baker	.50	.38	.29	.40	.09	.05	.30	.30

Comments

Able: There was no appreciable shock.

Baker: No shock mounted apparatus in this compartment appeared damaged although there was a considerable quantity of equipment, as fans, starting boxes, etc., broken loose from the bulkheads. It is evident that the damaging components of shock involved such small displacements that the clearances of about 1/2 inch provided sufficient protection with the type of mounts used.

BB34 General Discussion

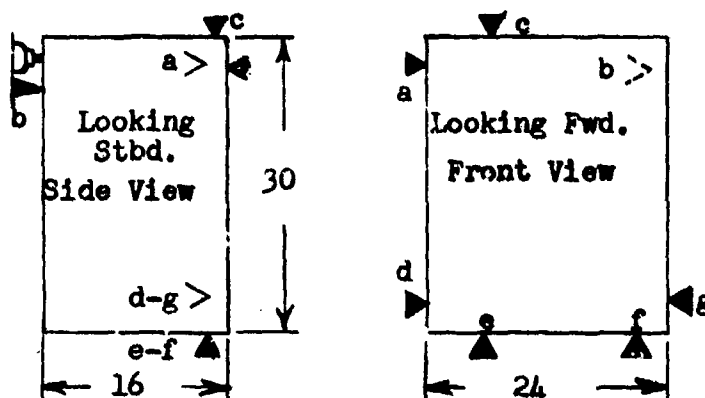
Able: There was no appreciable strain or damage.

Baker: The shock intensity through the ship was moderate. The intensity of the low frequency components of shock, as evidenced by the deflections of shock mounted apparatus, was as great on the superstructure decks as on the 3rd deck near the ship's centerline. Except for the failure of the P.P.I. mounting, in the C.I.C. room, the shock mountings proved adequate. There is little doubt but that shock mounted equipment with resonant frequencies no lower than 10 cps, and with mounts located so as to decouple the rocking modes, that 1/2 inch clearance would provide protection for shocks of these types. Equipment that has passed current shock specifications should be well able to withstand these shocks.

CA24 PENDING

CA24 #1 Gages:

Location: On Radio Transmitter, Model TSC, in Main Radio Room on the Communication Platform.



Type of Mounting: Short C type mounts on four bottom corners, L type mounts on two upper back corners. Vertical clearance to shoulders of mounts is 1/4 inch.

Photograph: BA CR 95-738-5

Vibration Modes:

Rocking Fore and Aft	12.0 cps
Rocking Athwartship	16.4
Translation Vertical	14.4 (some rocking)

Deflection (inches):

Gage CA24 #1	a	b	c	d	e	f	g
Able	.19	.25	.19	.05	.21	.21	.05
Baker	.34	.40*	.41	.09	.35	.35	.09

*Broken

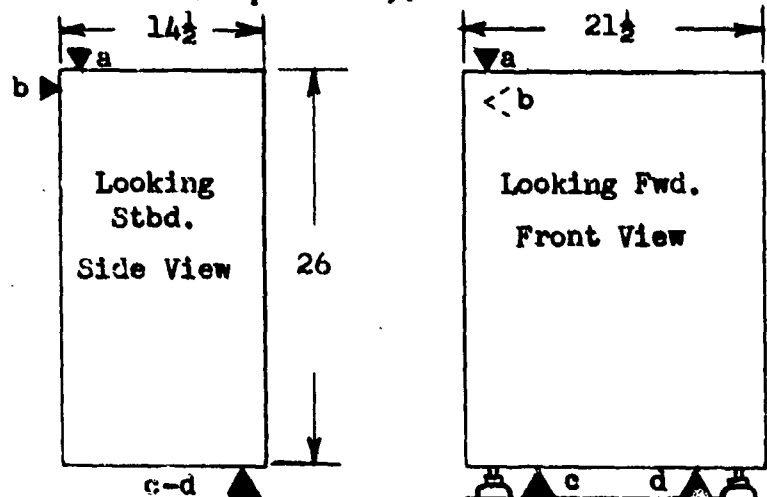
Comments

Able: Although there was very extensive damage just external to this compartment there was no visible damage within. The unit was mounted to the structures that were attached only to the deck. The major shock direction was vertical and the deflection was no greater than would be caused by a sustained acceleration of 5 g. There was no damage to the transmitter.

Baker: There was a much more severe shock resulting from the Baker test than for the Able test. Again the direction of greatest severity at this location was vertical. Although the mounts bottomed there did not appear to be any serious damage to the transmitter.

CA24 #2 Gages:

Location: On High Voltage Rectifier type CW-20280, a Unit of Mark 28 Radar; in Radar Transmitter Room (just above the communication platform).



Type of Mounting: L type mounts on four bottom corners. Clearance to shoulder of mount is about 1/16 inch, however the shoulder is one inch thick.

Photograph: CR 95-738-6

Vibration Modes:

Rocking Fore and Aft	6.7 cps
Rocking Athwartship	9.6
Translation Vertical	20.0

Deflection (inches):

Gage CA24 #2	a	b	c	d
Able	0.30	0.56	0.42	0.42
Baker	Room too damaged to obtain readings.			

Comments

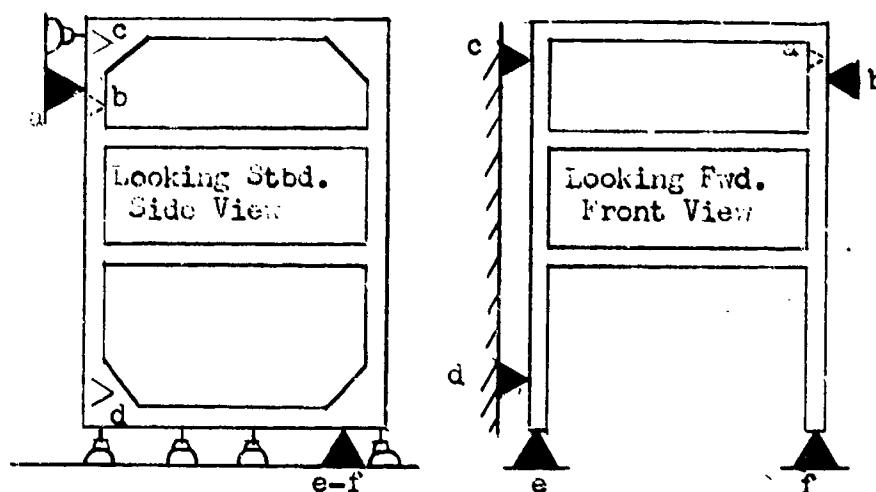
Able: The starboard bulkhead was slightly bent in by the blast, but there was no noticeable damage in the compartment. The shock as indicated by the displacement was severe. The mounts were deflected

vertically to at least 10 times their static load.

Baker: The compartment was severely damaged and was filled with a chaotic mass of loose material.

CA24 #3 Gages

Location: On Shock Mount Rack Containing Fire Control Radar Gear, located on Port Side of Radar Transmitter Room.



Type of Mountings: Four L type mounts under each side bottom edge. The L type mounts on upper back corners. Clearance 1/8 inch to shoulders of mounts.

Vibration Modes:

Rocking Fore and Aft	7.4 cps
Rocking Athwartship	8.0

Deflection (inches):

Gage CA24 #3	a	b	c	d	e	f
Able	0.70	0.75	---	0.34	0.07	0.09
Baker	Room too damaged to obtain readings.					

*Rubber of upper back shock mount failed.

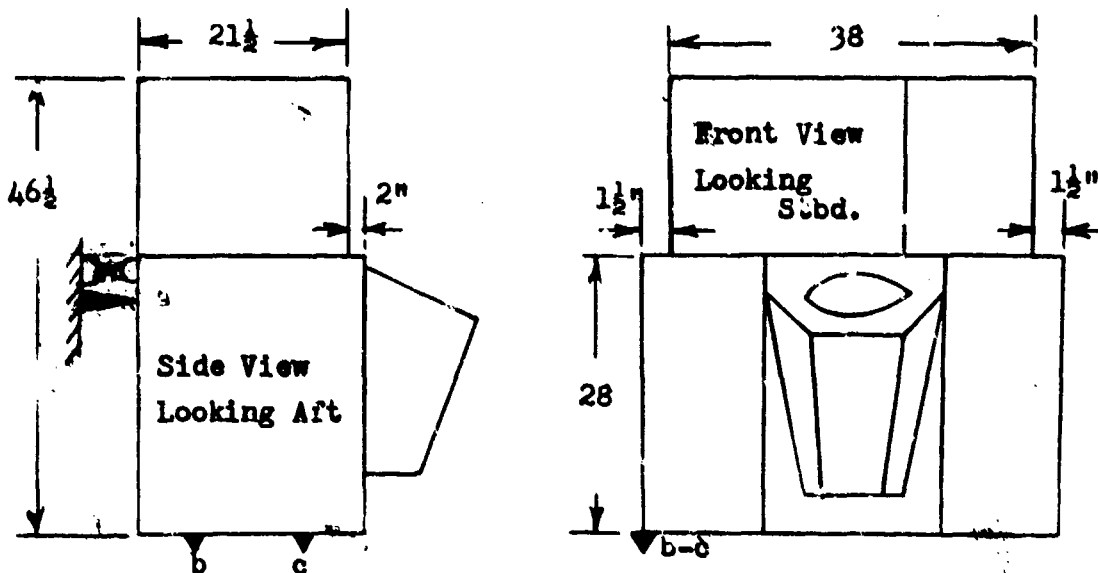
Comments

Able: This apparatus was attached to the deck and to bulkheads. The mounts attached to the bulkhead were strained and one failed. The vertical shock was minor compared with those transmitted by the bulkhead.

Baker: The compartment was in such chaotic condition that no measurements could be made. The Rack was still held in place by the mounts.

CA24 #4 Gages:

Location: On Plan Position Indicator, in C.I.C. Room.



Type of Mounting: Short C type mounts on four bottom corners. L type mounts on upper back corners of main unit. Vertical clearance 1/16 to 1/4 inch.

Photograph: BA CR 95-738-8

Vibration Modes:

Rocking Fore and Aft	4.6 cps
Rocking Athwartship	4.7

Deflection (inches):

Gage CA24 #4	a	b	c
Able	0.62	0.30	0.21
Baker	--	0.50	0.46

Comments

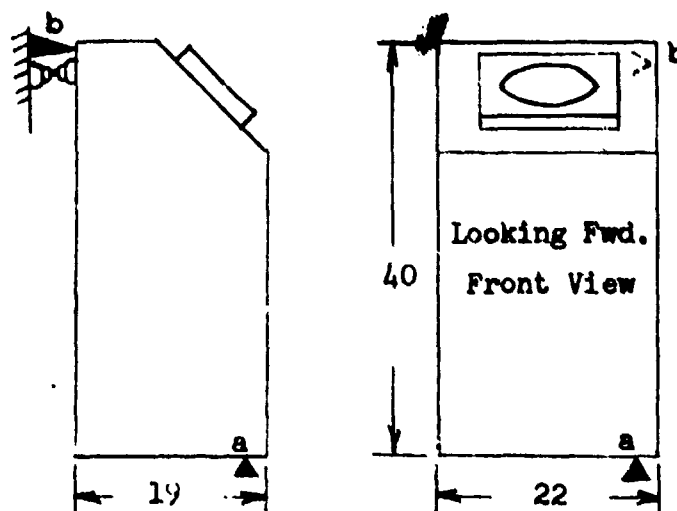
Able: Extensive structural damage existed in the space just forward of the C.I.C. room, but the C.I.C. room and the equipment in it were undamaged.

Baker: Considerable displacements occurred near the top of the P.P.I. as gage a was distorted too greatly for readings. The vertical shock was very severe as there was about 1/2 inch displacement downward

although the clearance was but 1/4 inch. This indicated bending of the structural parts.

CA24 #5 Gages:

Location: CB Film Position Indicator type CB-9540B, Near Center of Forward Bulkhead of C.I.S. Room.



Type of Mountings: Combination mounts on each of four bottom corners. These consist of C type mounts plus a rubber sandwich in parallel. Stabilizing L type mounts are located at upper back corners. Clearances were not determinable.

Photograph: BA CR 95-238-9

Vibration Modes:

Rocking Fore and Aft	15.3
Rocking Athwartship	10.4

Deflection (inches):

Gage CA24 #5

	a	b
Able	0.05	0.23
Baker	0.21	1.25

Comments

Able: There was no apparent damage to the P.P.I. or to its mounting supports. The displacements indicate a minor shock.

Baker: The displacements occurring during this test were about 5 times those occurring during the first test. The compression of 1.25 inches of the top mounts is extreme.

CA24 General Discussion

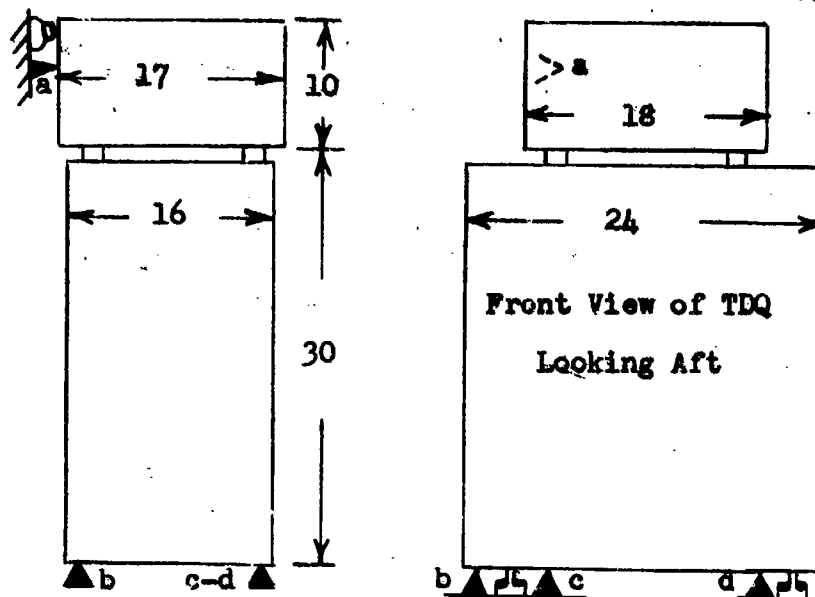
Able: Severe top side structural damage occurred, but inside of closed compartments the shock intensity was moderate for gear attached to decks. When mounts were attached to bulkheads, the shock displacements were large.

Baker: Considerable structural damage, machinery damage, and some flooding were caused by this test. The shock therefore should be considered of moderate intensity but not of the maximum intensity that would occur if the flooding were difficult to control with a crew aboard. The shock mounted apparatus are almost invariably located at points distant from the hull where the intensity of shock is greatly diminished. There is little question but that equipment that passes the Navy "High Impact" shock specifications could easily withstand the shock motions at these locations. In most of the cases where readings were not obtainable the mounts and gear were not seriously damaged. The shock mounted electronic gear was less vulnerable than the ship's machinery to this type of shock damage.

CA25 SALT LAKE CITY

CA25 #1 Gages:

Location: On Model T-2 Radio Transmitter, in Main Radio Station, on Communication Platform (near frame 400).



Type of Mounting: Short C type mounts on four bottom corners. L type stabilizer on top back corners. Clearance of mounts is about 1/8 inch.

Vibration Modes:

Rocking Fore and Aft	5.4 cps
Rocking Athwartship	3.8
Translation Vertical	20.0

Deflection (inches):

Gage CA25 #1	a	b	c	d
Able	0.55	0.25	0.19	0.17
Baker	0.38	0.50*	0.17	0.21

*Doubtful accuracy

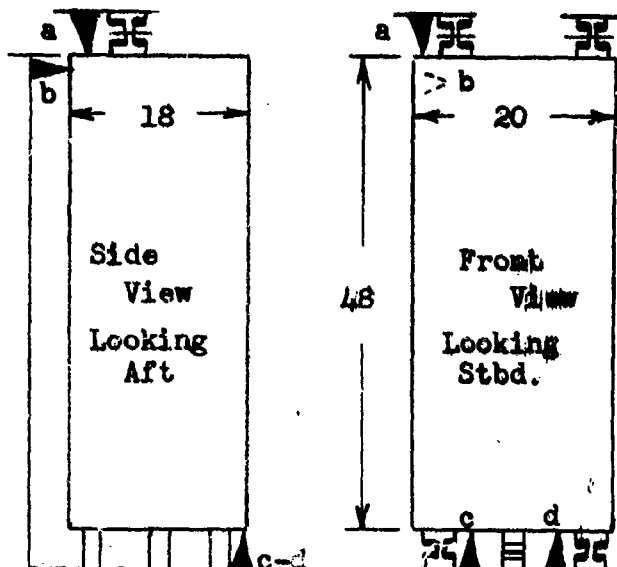
Comments

Able: A shock of sufficient intensity to bottom the mounts occurred, but there resulted no apparent damage to the equipment.

Baker: Except for the deflection of b, the displacements for this test were about the same as for Able. There was no apparent damage to the equipment.

CA25 #2 Gages:

Location: On Radar Transmitter type OG-52ABH, in Radar Transmitter Room (frame 45-47).



Type of Mounting: C type mounts used on four bottom corners and at center of four bottom edges. Two C type mounts are used on the upper back edge. Clearance to bottom 1/4 inch.

Photograph: BA CR 95-738-11

Vibration Modes:

Rocking Fore and Aft	10.6 cps
Rocking Athwartship	8.4
Translation Vertical	9.9

Deflection (inches):

Gage CA25 #2	a	b	c	d
Able	---	---	0.30	0.30

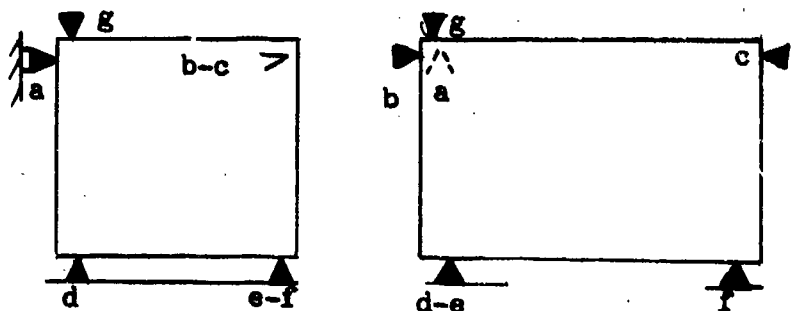
Comments

Able: The top mounts were destroyed. The lower mounts probably bottomed. The general damage within the transmitter room is minor, but the damage outside of the room is very extensive.

Baker: Because of the damage caused by Able test no observations were made for Baker test.

CA25 #3 Gages:

Location: On type CML-50ABH Automatic Gain Control Unit,
in Radar Transmitter Room (frames 45-47).



Type of Mounting: L type mounts on four bottom corners. The mounts have collapsed so as to rest on their shoulders. The shoulders can compress 3/8 to 1/2 inch. The unit is mounted in an angle iron frame.

Photograph: BA CR 95-738-12

Vibration Modes:

Rocking Fore and Aft	12.2 cps
Rocking Athwartship	9.8
Translation Vertical	16.7

Deflection (inches):

Gage CA25 #3	a	b	c	d	e	f	g
Able	0.82*	0.50	0.62*	0.62	0.22	0.34	0.34
Baker	----**	----**	0.28	0.30	0.40	0.40	1.10

*Gage crushed, limit of travel.

**Gages broken off.

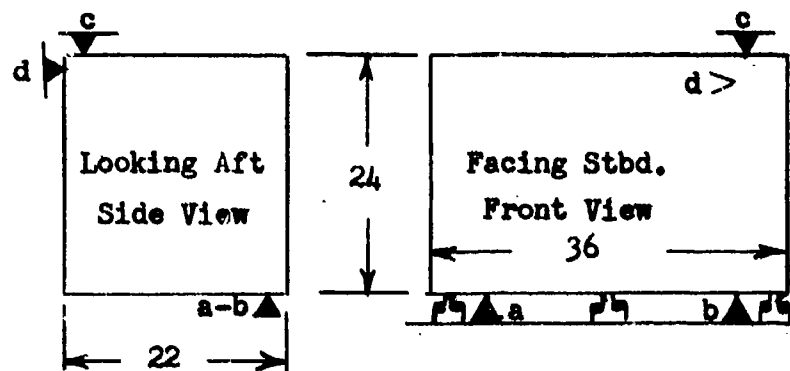
Comments

Able: The unit is in an angle iron frame which was welded to the deck and to an interior bulkhead. The unit collided with this frame indicating large displacements in the 3 principal directions. However, the unit did not appear to be damaged. The transmitter room did not suffer much damage, but damage just outside the compartment was severe. Some tubes in an adjacent transmitter (no shock mounts) were broken.

Baker: The intensity of shock was somewhat greater for Baker than for Able. It should be noted that an identical unit mounted just above the subject one, and on the same angle iron rack, tore loose from its mounts.

CA25 #4 Gages:

Location: On Range and Train Indicator type CRP-55ABC-1 in C.I.C. Room, Superstructure Deck.



Type of Mounting: Three C type mounts, spaced as shown above, extend the full depth of equipment. Vertical clearance of 5/16 inches.

Photograph: BA QR 95-739-1

Vibration Modes:

Rocking Fore and Aft	24 cps
Rocking Athwartship	8.3

Deflection (inches):

Gage CA25 #4	a	b	c	d
Able	0.13	0.11	0.46	0.62
Baker	0.30	0.25	1.60	0.50

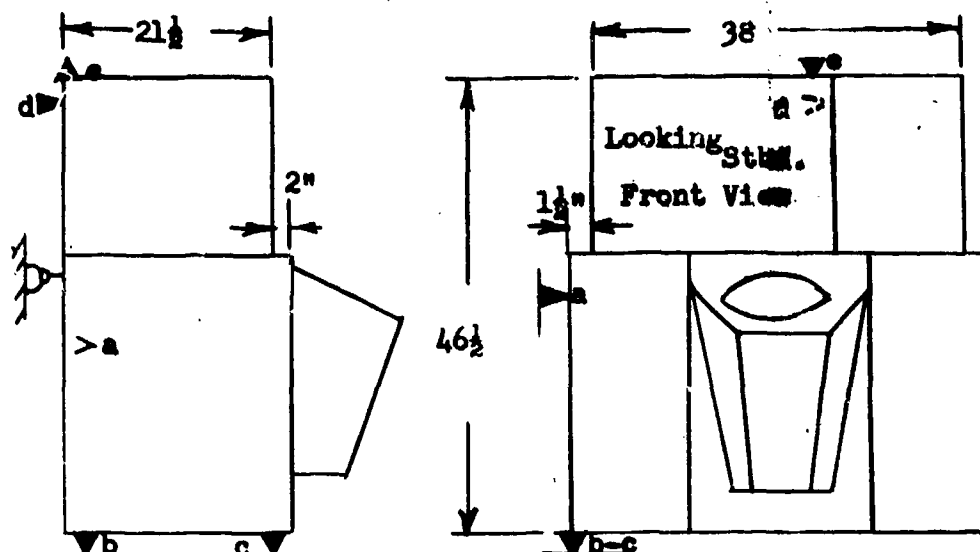
Comments

Able: The shock was greater in the downward than in the upward direction, however it was minor in nature. There was extensive damage just aft of the C.I.C. room, but none apparent in C.I.C.

Baker: A shock of considerable intensity in the vertical direction caused the mounts to bottom. There was no apparent damage.

CA25 #5 Gages:

Location: On Plan Position Indicator (main unit type
CG-35ACC) Model SC-2, in G.I.C. Room.



Type of Mounting: Short C type mounts at each bottom corner.
L type mounts on upper back corner of main unit. Vertical
clearance is about 1/8 inch.

Photograph: BA CR 95-739-2

Vibration Modes:

Rocking Fore and Aft	4.6 cps
Rocking Athwartship	4.5

Deflection (inches):

Gage CA25 #5	a	b	c	d	e
Able	0.26	0.30	0.42	1.60	0.72
Baker	0.19	0.50	0.50	0.75	1.66

Comments

Able: The shock mounts bottomed hard and there was considerable displacement after bottoming due to the bending of the cabinet parts. However, because of the softness of the mounts it is not probable that the shock was severe. There was no apparent damage to the unit.

Baker: The vertical displacements indicate considerable shock in that direction. There was no apparent damage to the unit.

CA25 General Discussion

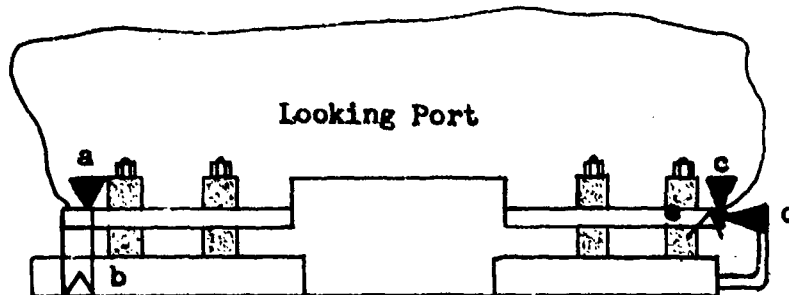
Able: The spaces just external to all of the compartments considered were exposed to the blast and suffered great structural damage. Inside of the compartments, however, there was little evidence of shock although bottoming of the shock mounted units occurred in many instances. As all antenna systems were swept away it must be concluded that the electronic gear is less vulnerable to shock of these types than associated equipment. Shocks caused by blasts of much greater intensities than these would not occur without destroying the compartment spaces involved. It may be assumed, therefore, that protection for greater intensities of shock than these is not required as far as air blast shock is concerned.

Baker: The ship suffered only minor hull and machinery damage. Nevertheless, the intensity of shock for this test was greater than for test Able. There were several cases of mount failure, and bottoming was quite general.

SS184 SKIPJACK

SS184 #1 Gages:

Location: On Shock Mounted Motor Generator Set, in Port Forward Corner of compartment below the control cubicle.



Type of Mounting: Mounts are as shown on each of the four bottom corners of the M-G set. The rubber is about 1 1/4 inches thick.

Photographs: BA CR 140-1601-5 and BA CR 140-1601-6

Deflection (inches):

Gage SS184 #1	a	b	c	d	e
Able	0.00	0.00	0.01	0.00	0.00
Baker	Ship sunk, no data obtained.				

Comments

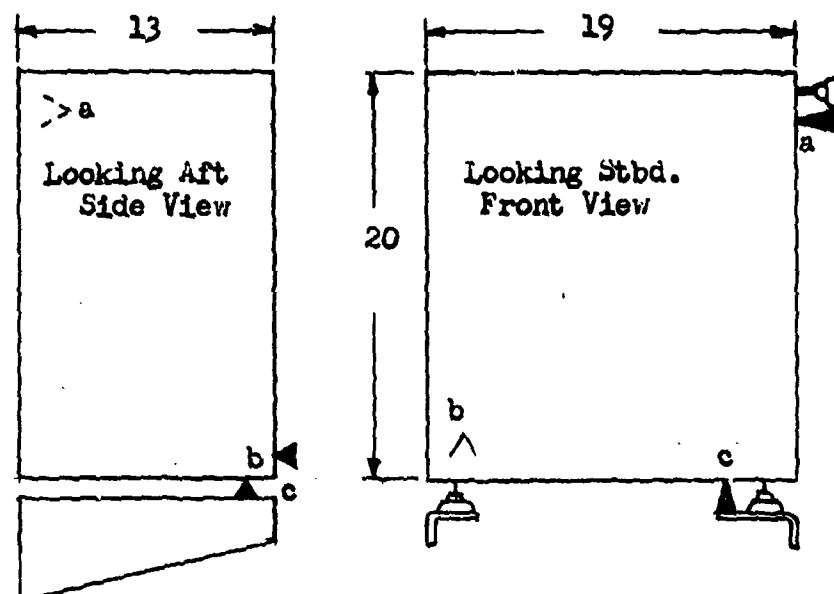
See "General Discussion" for this ship.

SS184 #2 Gages:

Location: On Radar Model SJ-a, type CW-43AAF-1 on Forward Starboard Side of Conning Tower.

Type of Mounting: L type mounts on four bottom corners and on upper back aft corner.

Photograph: BA CR 140-1601-7



Vibration Modes:

Rocking Fore and Aft	11.5 cps
Rocking Athwartship	11.3
Translation Vertical	14

Deflection (inches):

Gages SS184 #2	a	b	c
Able	0.07	0.07	0.09
Baker	-	-	-

Comments:

See "General Discussion" for this ship.

SS184 #3 Gages:

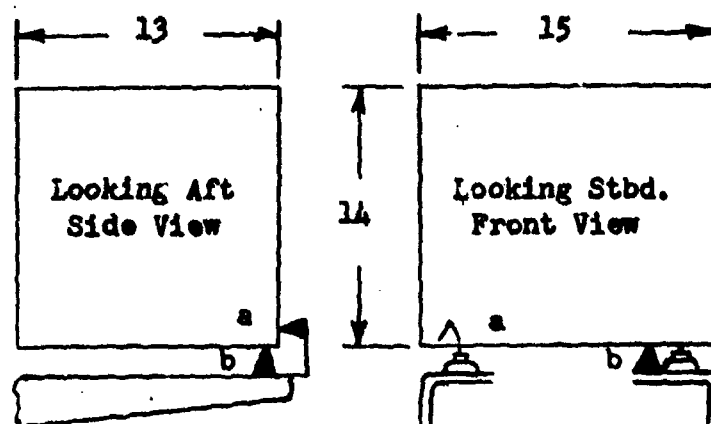
Location: On Radar Model SJ-a, type CEC-23 ADH, on Forward Starboard Side of Conning tower.

Type of Mounting: L type mounts on four bottom corners.

Photograph: BA CR 140-1601-8

Vibration Modes:

Rocking Fore and Aft	15.5 cps
Rocking Athwartship	15.0



Deflection (inches):

Gage SS184 #3	a	b
Able	— *	0.01
Baker	—	—

*Gage damaged by causes other than shock.

SS184 General Discussion

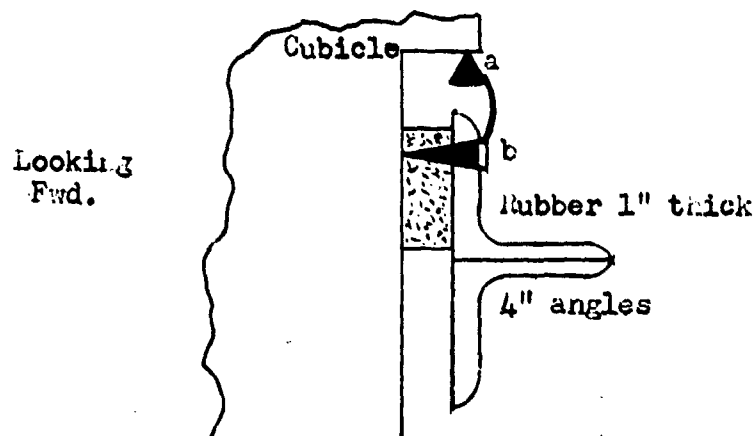
Able: There was no noticeable shock damage within the Skipjack. The intensity of shock was negligible.

Baker: The ship was sunk by Baker test and no test results are available.

SS196 SEA LAVEN

SS196 #1 Gages

Location: On Control Cubicle, Lower Starboard Edge about four feet from After Edge, in After Maneuvering Room. The gages are shown in the accompanying figure.



Photograph: BA CR 55-814-2

Deflection (inches):

Gage SS196 #1	a	b
Able	0.02	0.00
Baker	0.07	0.02

Comments

See "General Discussion" for this ship.

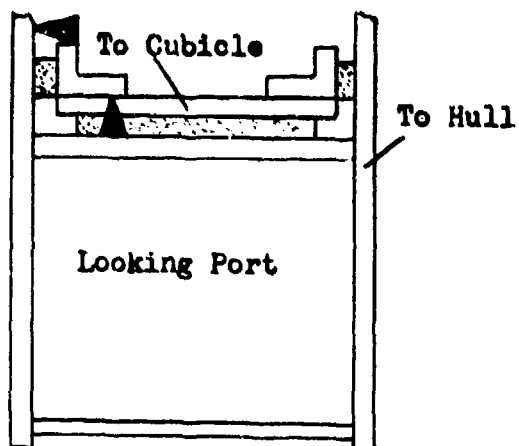
SS196 #2 Gages:

Location: On Control Cubicle, Upper Starboard Mount about 3.5 ft. from After Edge of Cubicle. The gages are shown in the accompanying figure.

Photograph: BA CR 55-814-3

Deflection (inches):

Gage SS196 #2	a	b
Able	0.00	0.02
Baker	0.03	0.02



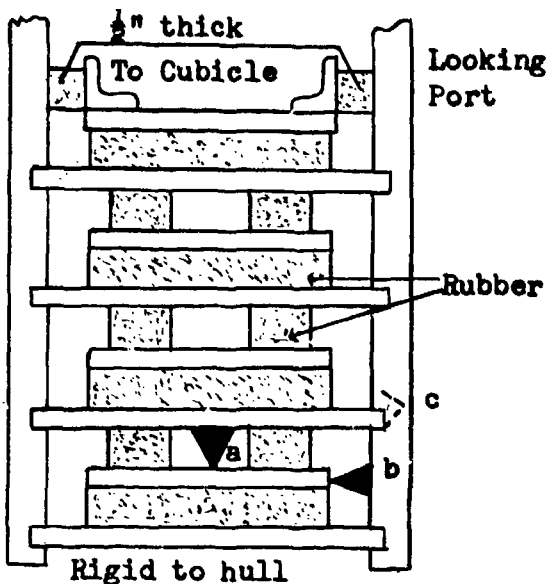
SS196 #3 Gages:

Location: On Control Cubicle, Upper Forward Starboard Corner, in After Maneuvering Room. Gage positions are shown in the figure below.

Mount. Rubber is 1" thick except as noted.

All steel that is rigid to hull is 3/4" thick.

The rest is 1/2" thick.



Photograph: BA CR 55-814-4

Deflection (inches):

Gages SS196 #3

Able

Baker

	a	b	c
Able	0.00	0.00	0.03
Baker	0.02	0.03	0.04

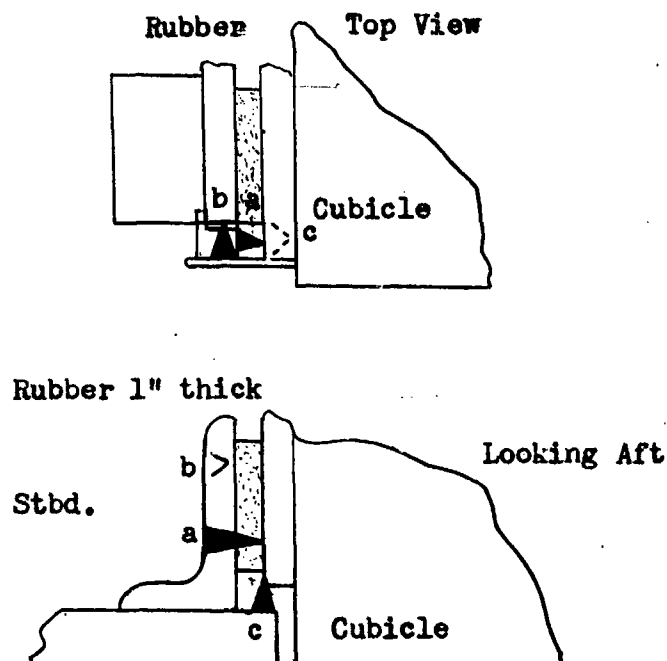
SS196 General Discussion

Able and Baker: There was an appreciable evidence of shock or shock damage within the Sea Raven after either the Able or the Baker test.

SS308 APOGAN

SS308 #1 Gages:

Location: On Control Cubicle, Lower Forward Starboard Mount in After Maneuvering Room. Gage positions are illustrated on the accompanying figure.



Photograph: BA CR 55-813-1

Deflection (inches):

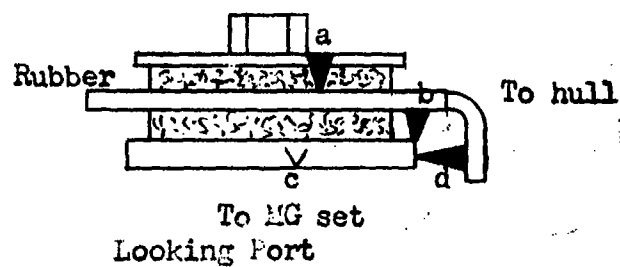
Gage SS308 #1	a	b	c
Able	0.00	0.01	0.00
Baker	--	--	--

Comments

See "General Discussion" for this ship.

SS308 #2 Gages:

Location: On #2 Lighting Motor Generator, Forward Upper Mount, on Port Side of After Maneuvering Room.



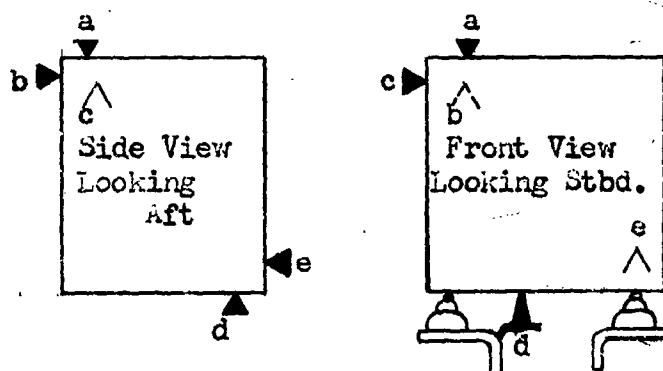
Photograph BA CR 55-813-3

Deflection (inches):

Gages SS 308 #2	a	b	c	d
Able	0.00	0.01	0.01	0.00
Baker	-	-	-	-

SS308 #3 Gages

Location: On Radar Transmitter-Receiver type CW-43AMF-1,
in starboard After Corner of Conning Tower.



Type of Mounting: L type mounts on four bottom corners and on two upper back corners. Clearance of mounts about 1/4 inch before bumping on shoulder.

Photograph: BA CR 55-813-8

Vibration Modes:

Rocking Fore and Aft	15 cps
Rocking Athwartship	15
Translation Vertical	15 (may be rocking)

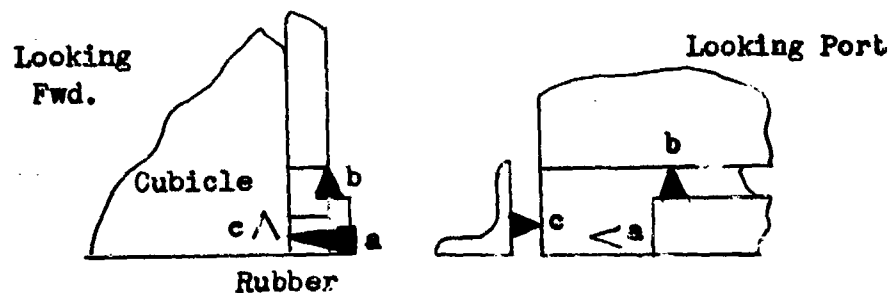
Deflection (inches):

Gages SS308 #3	a	b	c	d	e
Able	0.05	0.05	0.11	0.13	---*
Baker	---	---	---	---	---

*Gage broken.

SS308 #4 Gages:

Location: On Lower After Starboard Corner of Control Cubicle, in After Maneuvering Room.



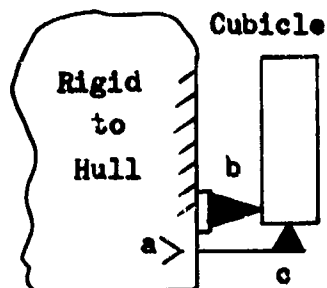
Photograph: BA CR 55-813-7

Deflection (inches):

Gage SS308 #4	a	b	c
Able	0.00	---	0.05
Baker	---	---	---

SS308 #5 Gages:

Location: On Upper Forward Port Corner of the Cubicle, in After Maneuvering Room.

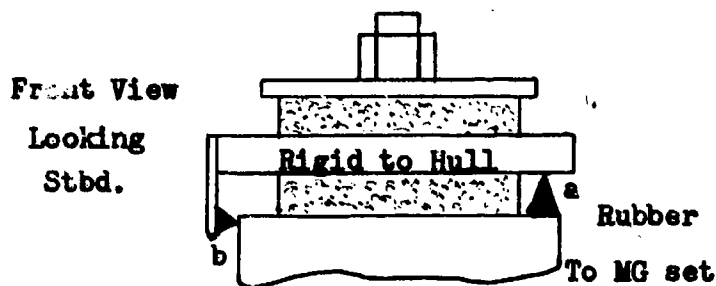


Deflection (inches):

Gage SS308 #5	a	b	c
Able	0.00	0.00	0.01
Baker	--	--	--

SS308 #6 Gages:

Location: On #1 Lighting Motor Generator Set. Upper Forward Mount, on Starboard Side of After Maneuvering Room.



Photograph: BA CR 55-813-5

Deflection (inches):

Gage SS308 #6

Able

Baker

a	b
0.00	0.00

--- --

SS308 General Discussion

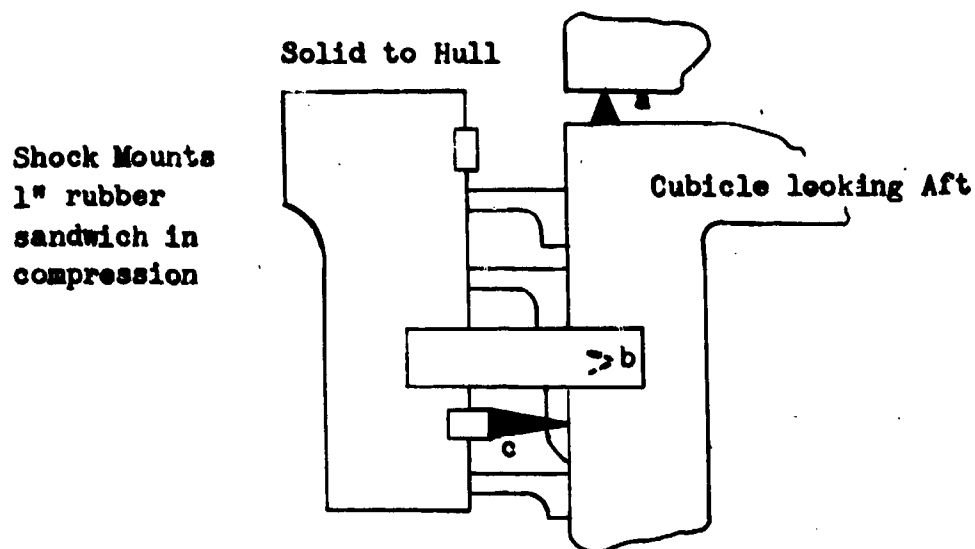
Able: There was no appreciable shock or shock damage within the Apogan during test Able.

Baker: The Apogan was sunk by test Baker and no gage readings were obtained.

SS335 DENTUDA

SS335 #1 Gages:

Location: On Upper Forward Starboard Corner of Control Cubicle in After Maneuvering Room.



Photograph: BA CR 55-813-9

Deflection (inches):

Gage SS335 #1	a	b	c
Able	0.00	0.00	0.02
Baker	0.05	0.05	0.06

Comments

See "General Discussion" for this ship.

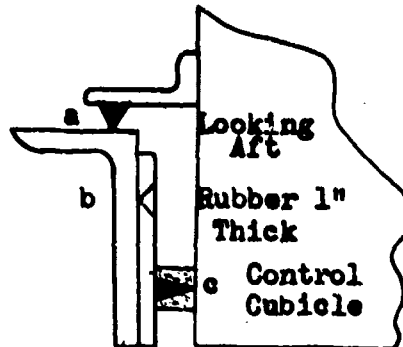
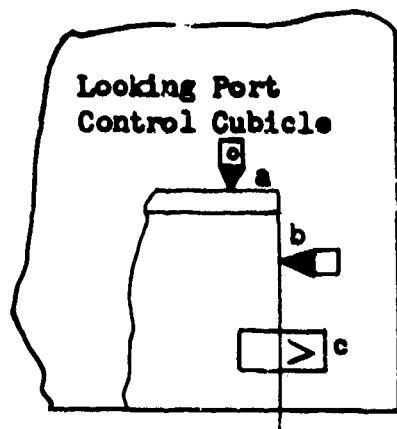
SS335 #2 Gages:

Location: On Lower Forward Starboard Corner of Control Cubicle in After Maneuvering Room.

Photograph: BA CR 55-813-10

Deflection (inches):

Gage SS335 #2	a	b	c
Able	0.00	0.00	0.00
Baker	0.04	0.07	0.05

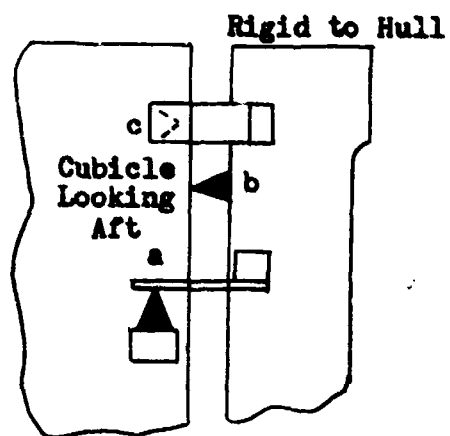
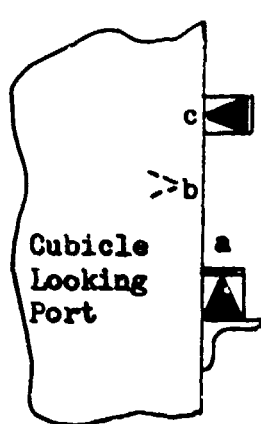


Comments

See "General Discussion" for this ship.

SS335 #3 Gages:

Location: On Upper Forward Port Corner of Control Cubicle in After Maneuvering Room.



Photograph: BA CR 55-813-11

Deflection (inches):

Gages SS335 #3

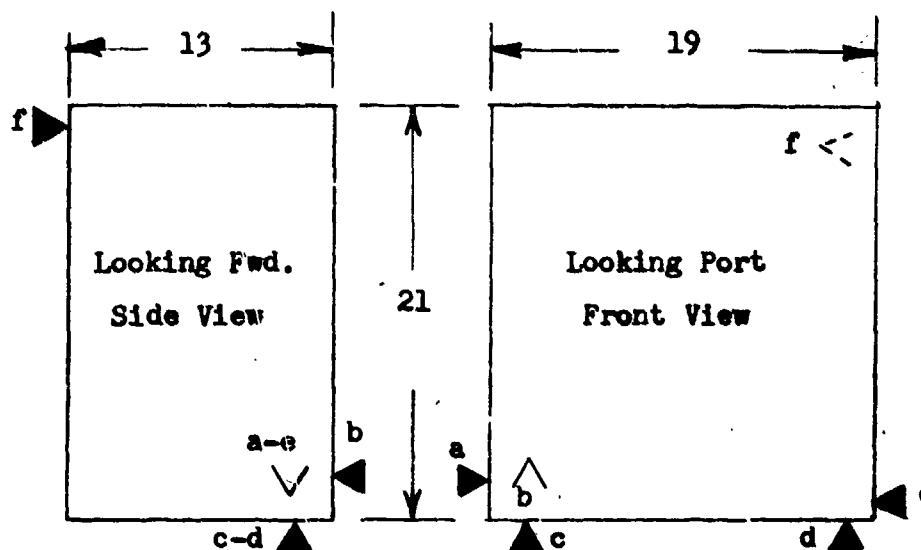
	a	b	c
Able	0.02	0.00	0.00
Baker	0.06	0.05	0.07

Comments

See "General Discussion" for this ship.

SS335 #4 Gages:

Location: On Model SJ-1 Radar Transmitter-Receiver type CW-43AAF-1, at Center of Port Side of Conning Tower.



Type of Mounting: L type mounts on four bottom corners and on two upper back corners. Clearance of mounts is about 1/4 inch to their shoulders which are about 1 inch thick.

Photograph: BA CR 55-813-12

Vibration Modes:

Rocking Fore and Aft	13.1 cps
Rocking Athwartship	15
Translation Vertical	15 (some rocking)

Deflection (inches):

Gage SS335 #4

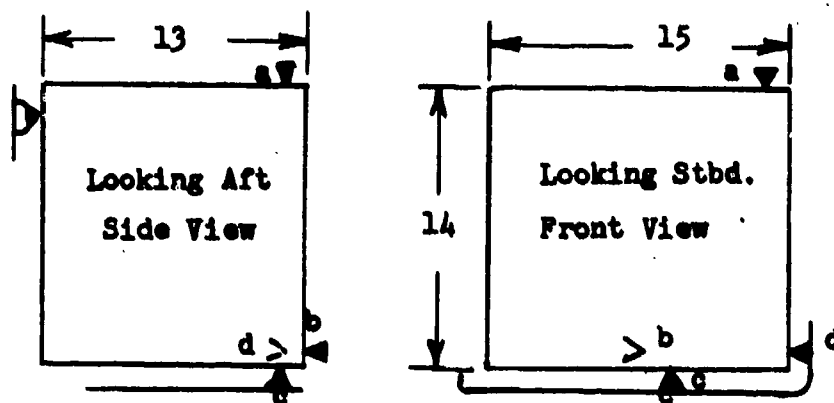
	a	b	c	d	e	f
Able	0.00	0.02	0.01	0.01	0.00	0.02
Baker	0.14	0.29	0.10	0.09	0.10	0.07

Mounts

See "General Discussion" for this ship.

SS335 #5 Gages:

Location: On Model SJ-1 Radar Main Control Unit type
CBB-23ADH, at Center of Starboard Side of Conning Tower.



Type of Mounting: L type mounts on each of four bottom corners and on the two top back corners. Clearance 1/16 to 1/8 inch to shoulders of mounts.

Photograph: BA CR 55-81A-1

Deflection (inches):

Gage SS335 #5

	a	b	c	d
Able	0.01	0.00	0.01	0.01
Baker	0.15	--	0.07	0.03

SS335 General Discussion

Able: There was no appreciable shock, or shock damage, within the Doryuda caused by test Able.

Baker: The Doryuda suffered very minor damage from the Baker test. Some small leaks developed that caused it to loose the small amount of buoyancy that it had, but if personnel had been aboard no trouble would have occurred. From displacements recorded on similar gear on the SS283 Dragonet, which was subjected to a controlled depth charge test (NRL Report O-2362) it is estimated that the

Baker test was about equivalent to a 300 lb. depth charge distant about 100 to 150 ft. ahead of the submarine. The deflections of the apparatus were of small magnitude and little shock damage occurred.

GENERAL CONCLUSIONS

Able Test

Surface Ships

The following generalizations can be made from general observations and from the lead gage data concerning Able blast and its effects on shock mounted equipment in surface ships.

1. There was no appreciable shock intensity below the main deck.
2. There was little shock damage to equipment that was contained within closed compartments above the main deck, as long as: (a) the compartment was not torn open so as to expose the equipment to the direct blast, (b) the equipment was mounted only to the deck and, (c) there was sufficient clearance (about 6" from central parts of exterior bulkheads) to prevent collisions.
3. Stabilizing mounts, that connected the top of an equipment to a bulkhead, very frequently failed. It is suggested that such stabilizing mounts include suitable shaped strap iron components that will deflect plastically at stresses several times that normally encountered and with clearances of several inches. Under no circumstances should any vulnerable equipment be mounted to exterior bulkheads.
4. It can be concluded that for equipment mounted to decks or protected interior bulkheads a minimum clearance of 1/2 inch would be sufficient to adequately protect equipment from severe bottoming because of translational motions, if the translational frequencies of the mounted equipment are greater than 10 cps. However, displacements involved in rocking modes were several inches in amplitude and a redesign and relocation of the mounting systems should be done to adequately protect the equipment. If sufficient clearances were provided, the displacements would not be objectionable for the brief period of the shock. Bottoming of shock mounted equipment occurred up to 1500 yards from the bomb, but little serious damage to this equipment occurred beyond 1000 yards. Plates 3 and 4 show typical displacements of two kinds of equipment. The mounting arrangements for all units of a given type were very similar. The

flexibility and lack of strength of exterior bulkheads caused them to deform and to be destroyed before more than moderate shock intensities were transmitted to interior deck surfaces. Because of the greater structural strength and rigidity of the heavier ships a moderate damage of their external members caused a more severe shock within the compartments than they enclosed than did corresponding structural damage aboard a destroyer.

Able Test

Submarines

The nearest submarine to the Able blast that was instrumented with lead gages was about 1000 yards. There was no appreciable shock damage or intensity of shock within surfaced submarines at this distance. The shock would be expected to be less for submerged vessels. Deflections of shock mounted equipments were generally less than 0.1 inch. It should be noted that the shock mounted equipment aboard submarines was more rigidly mounted and the mounts were better located (reduced coupling between the rocking and translation modes of vibration) than was the equipment aboard other ships.

Baker Test

In destroyers the shock mounted equipment, that was instrumented with lead gages, was located on the superstructure decks. In the cruisers the instrumented equipment was also on the superstructure decks although the C.I.C. room was an interior compartment just above the main deck. The battleship had instrumented shock mounted equipment both on the 3rd deck and on the signal and flag decks. As the underwater shock is transmitted to the ship via the underwater hull it is to be expected that the shock would have attenuated to relatively small intensity at these locations. Nevertheless the displacements of shock mounted apparatus was nearly as great in the Baker test as for Able for equipment in destroyer superstructures and for ship at equal distances from the bombs. In the cruisers the shock within superstructure compartments was of greater intensity for the Baker test than for the Able for ships at equal distances from the bombs. In the battleship the shock, as evidenced by the deflections of shock mounted apparatus, was as great in the superstructure as on the 3rd deck near the ships centerline. It is apparent that the rigidity of battleships and cruisers is sufficient to transmit a considerable intensity of low frequency shock components from the hull to remote parts of the ship. It can be concluded however, that shock mounted electronic equipment,

located distant from the hull of a ship, can withstand shocks caused by underwater explosions, better than machinery items located near the hull. If it is conceded that electronic equipment is to be located at considerable distances from the hull, as was the case for all equipment considered in this report, then the present Navy "High Impact" shock specifications can be relaxed by a limited amount. This does not apply to equipment mounted within submarines about which nothing can be said as no submarine that suffered only moderate damage was instrumented with lead gages.

Plates 5 and 6 show the relative displacements of two types of equipment, each type of which was mounted in a similar manner on many different ships. These are comparable with similar charts for the Able test. It can be approximately stated while considerable bottoming of shock mounted equipment occurs for ships up to about 1500 yards from the bomb for both Able and Baker tests, there was little extensive damage to the mounts or their supported equipments at distances greater than 1000 yards. At distances of about 900 yards or less, for Baker test, the shock mounts and their supported equipment are subject to considerable damage at all locations on a ship.

Miscellaneous Shock Intensity Notes

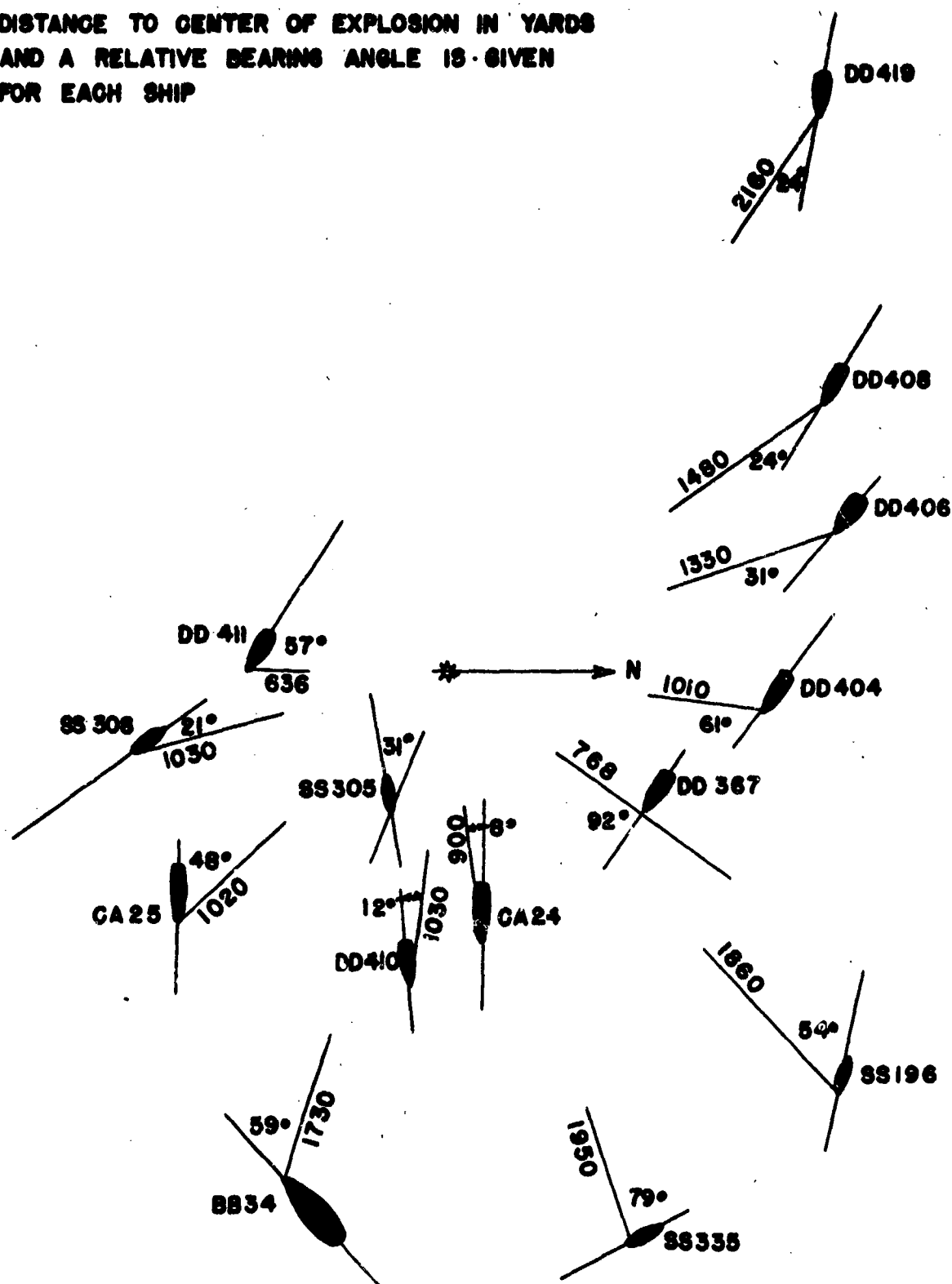
Several factors should be emphasized concerning the general maximum intensity of shock which ship's equipment must be required to withstand. It is generally agreed that for non-contact underwater explosions, equipment on board ship should be constructed and mounted so as to remain operable as long as the hull structure prevents uncontrollable flooding. It is apparent from the Bikini test that equipment protected from the direct Able blast, and built to withstand the maximum shock from underwater explosions, can easily withstand the shock caused by the Able test. Exceptions would be made for equipment mounted on, or very near to, exposed external decks and bulkheads because of the large displacements involved.

For Baker test only one ship considered in this report suffered a shock which would border on uncontrollable flooding. This was the DD410, located about 630 yard from the explosion which was off the starboard beam. From a superficial observation of the shock damage there was no doubt that equipment built to pass present shock specifications would have difficulty surviving a shock of this severity.

The Pensacola (CA24) was about 770 yards from the Baker explosion as measured from near midship. The explosion was off the bow of the ship. While some flooding occurred, the damage to the hull was far from the limit of uncontrollable flooding. An intensity of shock, as would be caused by the explosion off the beam of the ship and at a distance of about 600 yards, would be expected to be of a limiting value. These figures are taken, as they are close to the orientation of the Hughes (DD410). Other ships, as the New York and the Salt Lake City, suffered relatively minor shocks compared with the limiting value set by uncontrollable flooding.

TARGET ARRAY OF SHIPS INSTRUMENTED WITH "X" GAGES TEST ABLE

DISTANCE TO CENTER OF EXPLOSION IN YARDS
AND A RELATIVE BEARING ANGLE IS GIVEN
FOR EACH SHIP

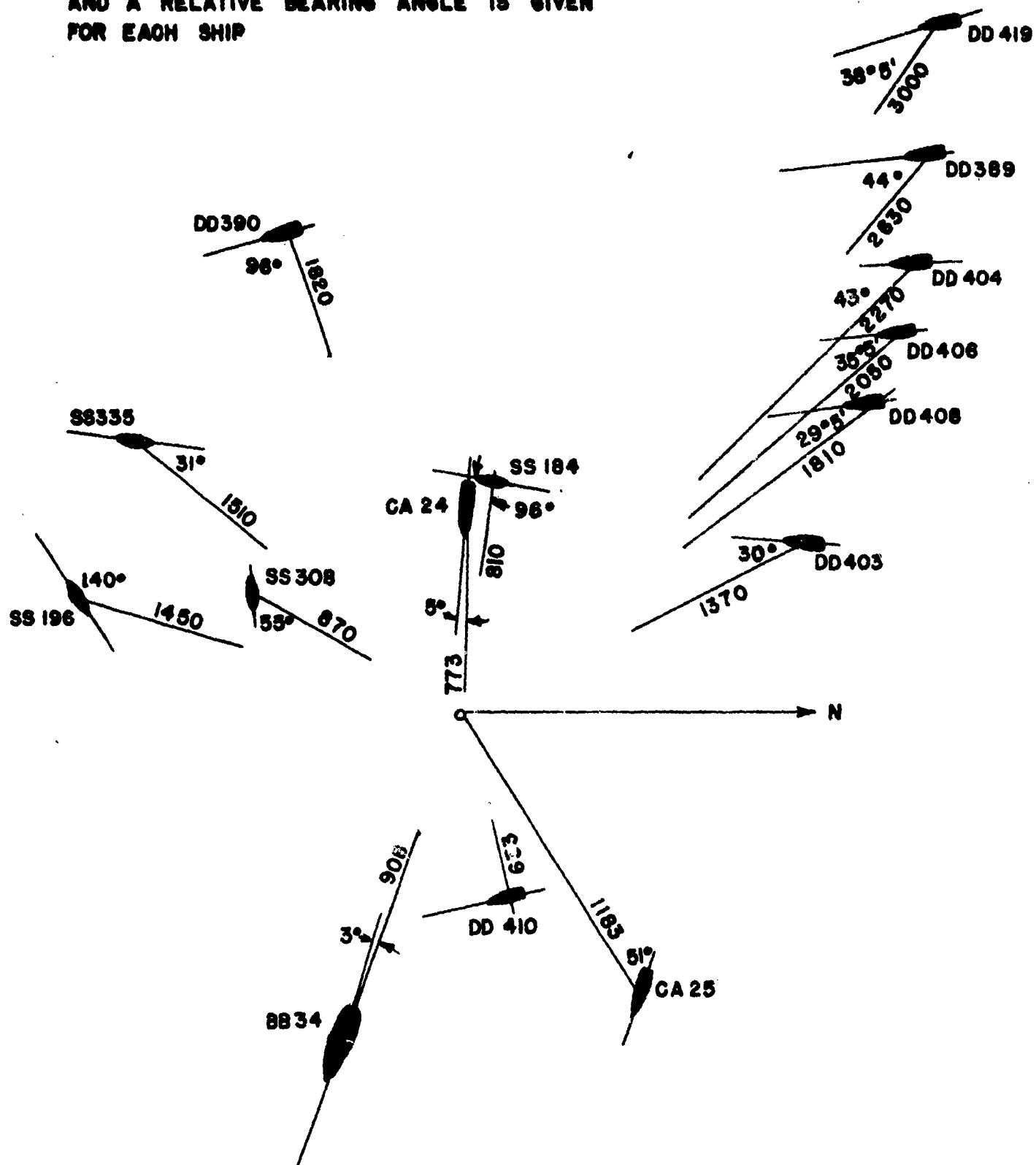


TOP
SECRET

PLATE I

TARGET ARRAY OF SHIPS INSTRUMENTED WITH "X" GAGES TEST BAKER

DISTANCE TO CENTER OF EXPLOSION IN YARDS
AND A RELATIVE BEARING ANGLE IS GIVEN
FOR EACH SHIP



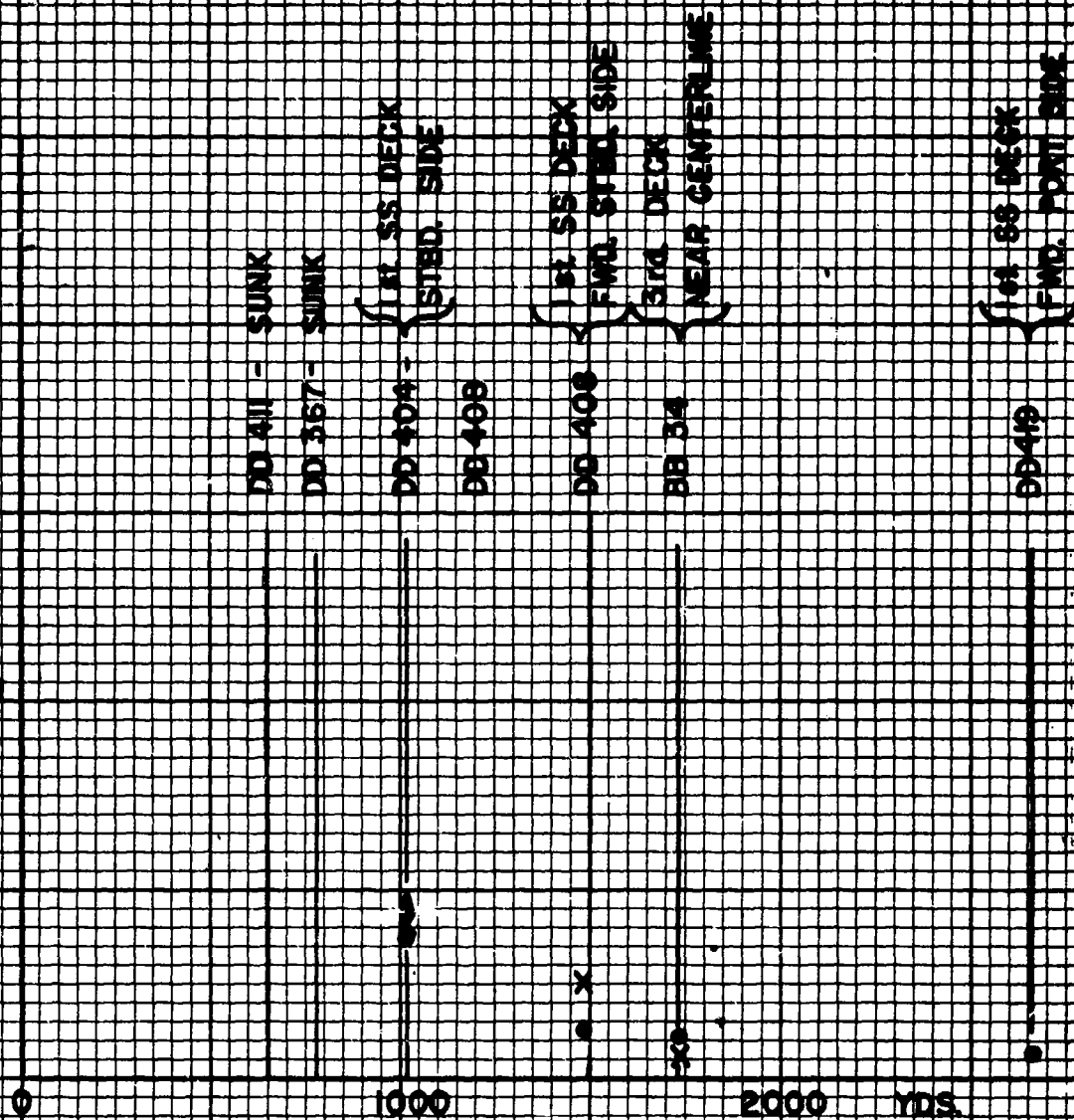
TOP
SECRET

PLATE 2

**MAXIMUM RELATIVE DISPLACEMENT OF RADIO RE-
CEIVER, MODEL RRO OR RCK WITH RESPECT TO ITS SUPPORTS
ABLE TEST:**

- VERTICAL, DOWN
- X AFTWARTSHIP, TOP OF RECEIVER

AN ARROW ATTACHED TO A POINT INDICATES BOTTOMING



DESTROYERS SEVERE TOP SIDE LITTLE DAMAGE
SUNK ——— DAMAGE ———

NATURAL FREQ. OF RRO ON ITS MOUNTS;
VERTICAL TRANSLATION - 12 CPS; ROCKING - 9 CPS (BOTH LOWER MODES)

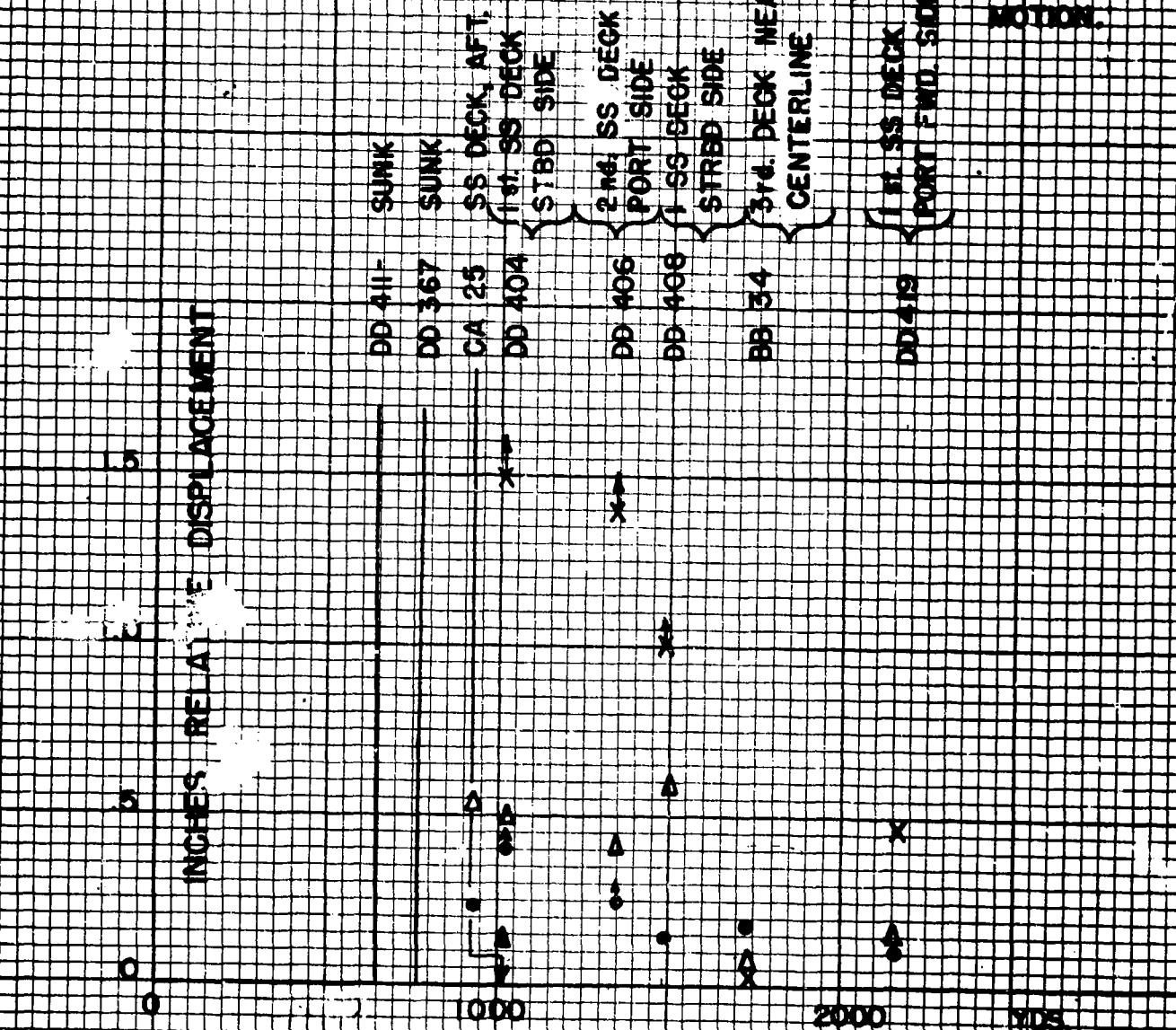
MAXIMUM RELATIVE DISPLACEMENTS OF RADIO TRANSMITTER, MODEL TDQ, WITH RESPECT TO ITS SUPPORTS

ABLE TEST:

● VERTICAL, DOWN
X ATHWARTSHIP, TOP
OF UNIT

▲ FORE & AFT, TOP OF UNIT

▲ FORE & AFT, BOTTOM OF UNIT
AN ARROW ATTACHED TO A POINT
INDICATES THAT BOTTOMING PREVENTS
GREATER
MOTION.



DESTROYERS ← SEVERE → LITTLE DAMAGE
SUNK TOP SIDE TO SHIPS
DAMAGE

NATURAL FREQ. OF TDQ ON ITS MOUNTS:

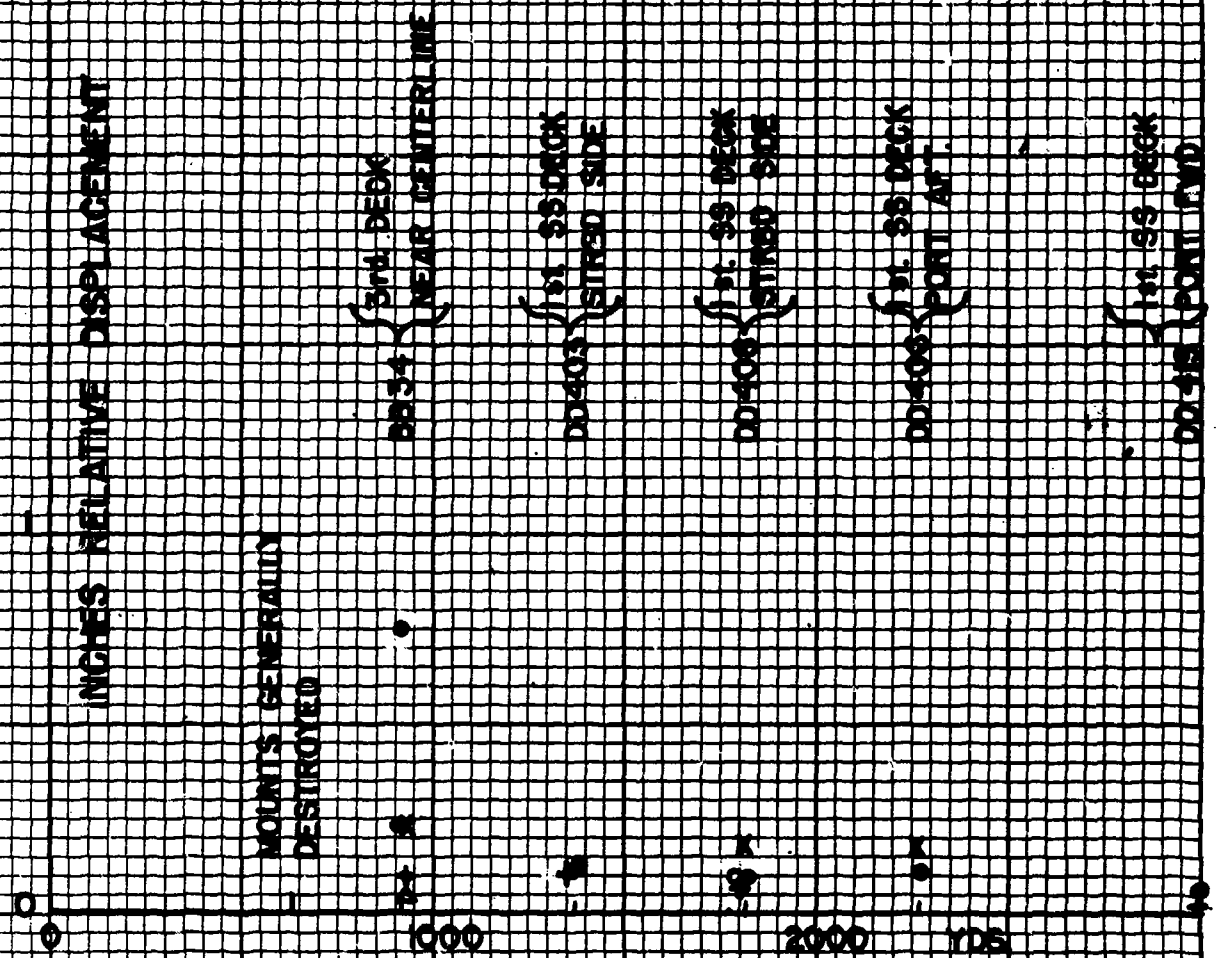
VERTICAL TRANSLATOR - 12 CPS.

ROCKING (TWO LOWER MODES) - 4 TO 7 CPS.

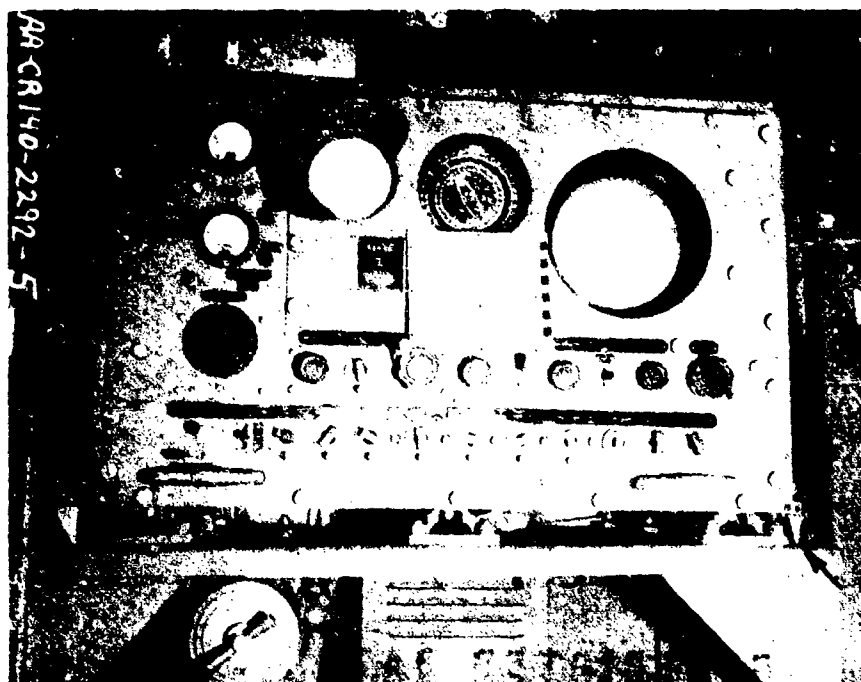
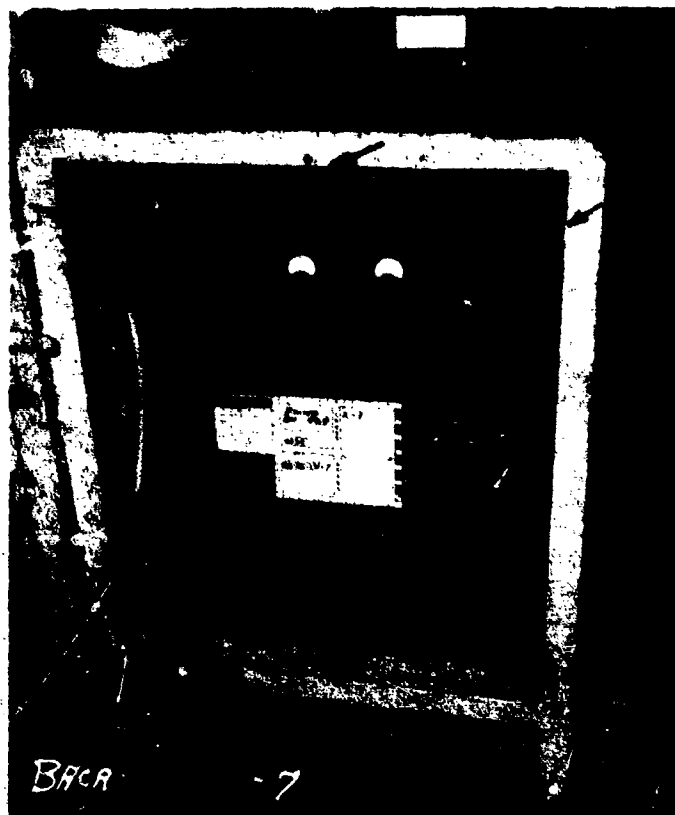
MAXIMUM RELATIVE DISPLACEMENT OF RADIO RE-
CEIVER, MODEL REQ OF ROCK WITH RESPECT TO ITS SUPPORTS.

BAKER TEST:

- | | |
|----------------------------------|-----------------------------------|
| ▲ FORE & AFT, TOP OF RECEIVER | ○ VERTICAL, UP |
| ▲ FORE & AFT, BOTTOM OF RECEIVER | × ATHWARTSHIP, TOP OF RECEIVER |
| ● VERTICAL, DOWN | + ATHWARTSHIP, BOTTOM OF RECEIVER |



NATURAL FREQ.: VERTICAL 12 CPS (STATICS DEF. 0.07")
ROCKING - 8 TO 10 CPS
(BOTH LOWER MODES)



TYPICAL INSTALLATIONS OF "X" AS LEAD GAGES
(ARROWS POINT TO GAGES)

CONFIDENTIAL

RESTRICTED DATA

ATOMIC ENERGY ACT - 1946

SPECIFIC RESTRICTED DATA CLEARANCE NOT REQUIRED!
USE MILITARY CLASSIFICATION SAFEGUARDS

CONFIDENTIAL



Defense Special Weapons Agency
6801 Telegraph Road
Alexandria, Virginia 22310-3398

TRC

18 April 1997

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ATTENTION: OMI/Mr. William Bush (Security)

SUBJECT: Declassification of Reports

The Defense Special Weapons Agency has declassified the following reports:

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AD-366589	XRD-200-Section 9✓ <i>original</i> ✓
AD-366590	XRD-204-Section 13✓
AD-366591	XRD-183✓
AD-366586	XRD-201-Section 10✓ <i>original</i>
AD-367487	XRD-131-Volume 2✓
AD-367516	XRD-143✓
AD-367493	XRD-142✓
AD-801410L	XRD-138✓
AD-376831L	XRD-83✓
AD-366759	XRD-80✓
AD-376830L	XRD-79✓
AD-376828L	XRD-76✓
AD-367464	XRD-106✓
AD-801404L	XRD-105-Volume 1✓
AD-367459	XRD-100✓

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18 April 1997

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AD-376833L ✓	XRD-95 ✓
AD-376832L ✓	XRD-94 <i>re-ingest</i> ✓
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Ardueth Jarrett
ARDITH JARRETT
Chief, Technical Resource Center